Chemical Engineering

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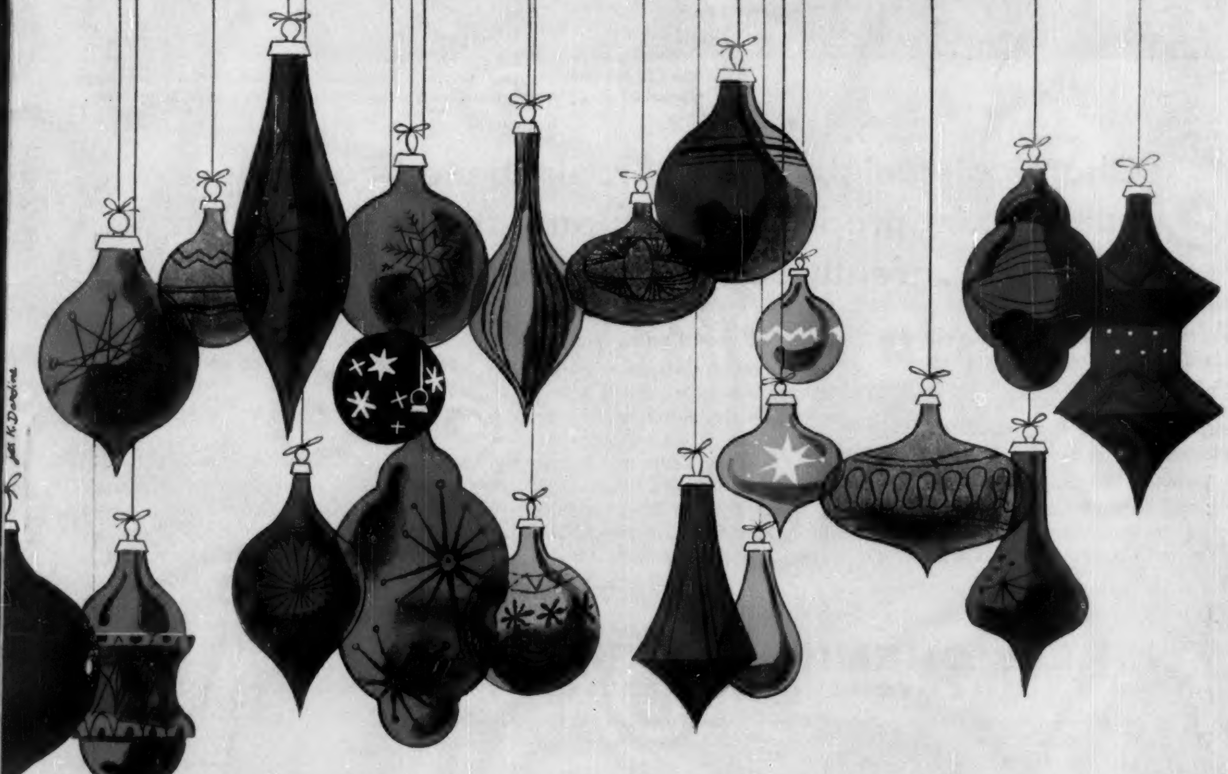


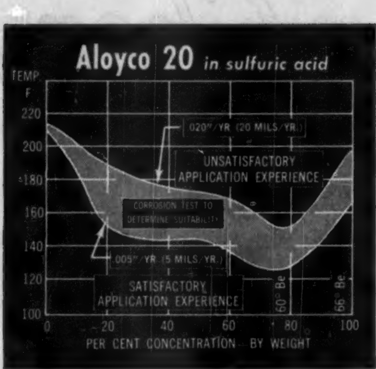
COSTS OF SOLVENT RECOVERY SYSTEMS

MEDLEY OF SALARY DATA FOR 1958

ANNUAL EDITORIAL INDEX

SEE PAGE TWO

A



B

C

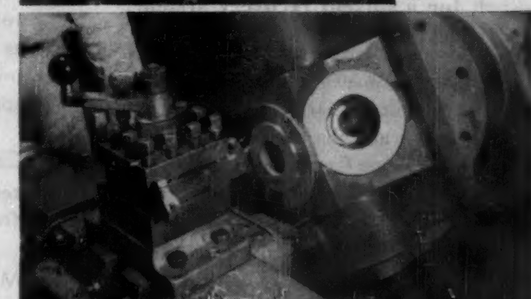
A. Your Problem in handling corrosives is discussed with a specialist when you sit down with an Aloyco Sales Engineer. He handles only one line, knows his business.

B. Right Alloy for your application is based on 29 years of specialized experience in the field plus continuing research in Aloyco metallurgical labs.

C. Valve Casting is made from Aloyco design in Aloyco foundry, only foundry ever built to produce pressure-tight Stainless Steel Valve castings, exclusively.

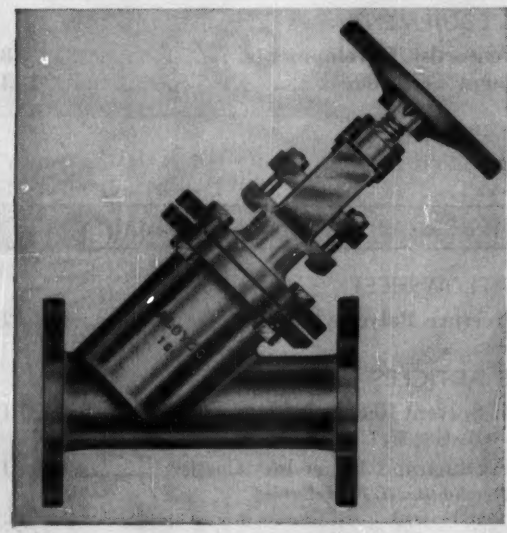
D. Special Techniques in machining stainless steel, plus most modern equipment in Aloyco plant assure you precise tolerances, trouble-free performance.

E. Aloyco Y Valve, shown here in various stages of production, is one of Aloyco's complete line of valve types, alloys, sizes, pressures—including nuclear valves.



D

BEHIND EVERY ALOYCO VALVE...



E

specialization

. . . to help you handle corrosives

Valves often look alike—even stainless steel valves. But they won't necessarily perform alike when you get them into the line. Here are some of the special skills and facilities that make the difference between Aloyco valves and others. Some of the "extras" you get with Aloyco valves are staying power, minimum maintenance, trouble-free operation in severe as well as mild corrosive service. Doesn't it make sense that the one company specializing in the manufacture of Stainless Steel Valves exclusively is your best source of supply?

Longer Lasting ALOYCO VALVES

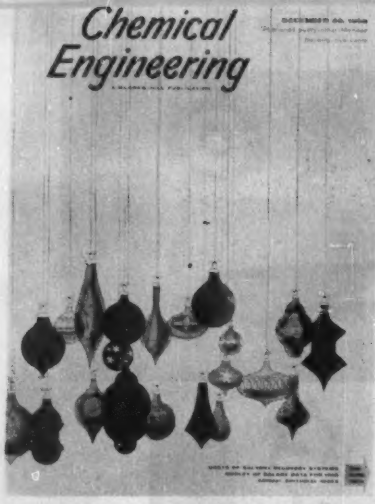
SUBSIDIARY OF WALWORTH

1ST IN CORROSIVE SERVICE

8.2

ALLOY STEEL PRODUCTS COMPANY

1301 WEST ELIZABETH AVENUE, LINDEN, N. J.



Chemical

DECEMBER 29, 1958

TWENTY-SIXTH OF TWENTY-SIX ISSUES

26/26

How much for a solvent recovery system?

Right from charts, here are the answers for your preliminary estimates. New method estimates costs of building a carbon-adsorption solvent recovery plant and the cost of running it. Also, you can determine the feasibility of solvent recovery for your specific problems. (p. 51)

How to deal with cost of byproducts

Standard methods don't always work. Here's a better way to figure costs when you're dealing with byproducts or coproducts. It's based on engineering know-how to help you allocate joint costs—a common problem in controlling process operations. (p. 61)

A potpourri of salary optimism

A 1958 income miscellany reveals five encouraging facts: A five-year course really pays off; our industry pays better than average; ceramic engineers do very well; so do biologists; graduates at the University of Michigan did better in 1958 than in 1957. (p. 67)

Your annual index and reference . . .

Annual editorial index of Chemical Engineering proves that 26 issues brought you more news, more helpful articles, more everything. There are 2,308 listings as compared with 1,955 in prerecession 1957. (p. 81)

Developments in Chemical Engineering

Practice of Chemical Engineering

Engineering

Vol. 65, No. 26

Other Regular Features

Reader Service

CE is edited for the engineers who develop, design, build, operate, maintain and manage chemical operations of all types. More engineers subscribe to CE than to any other magazine in the field. Print order of this issue:

48,562

Chemical Engineering

This issue's top features in ...

Petrochemicals & Petroleum Refining

DEC. 29, 1958

Also of Basic Interest

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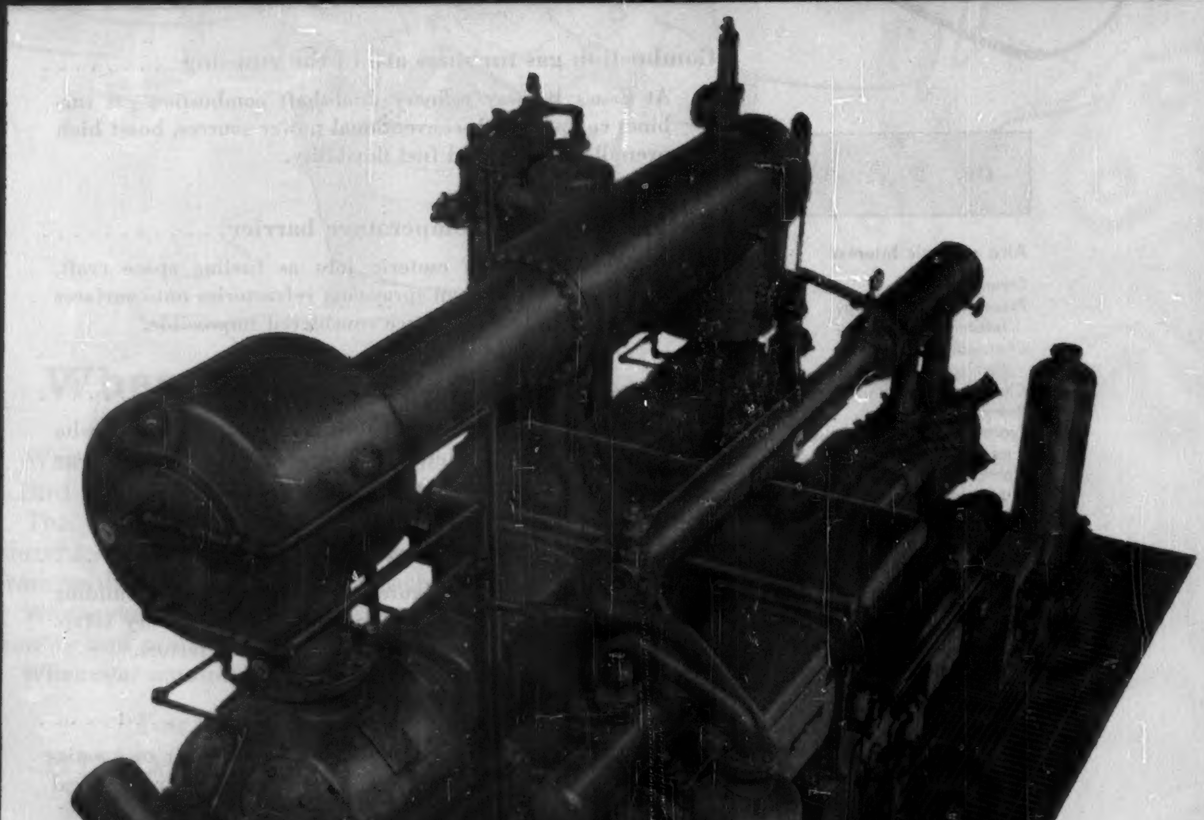
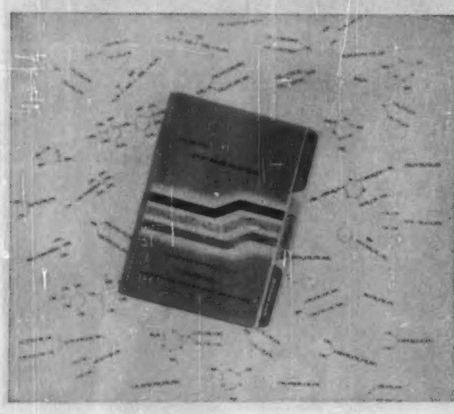
CLASS FE FOR PROCESS WORK



2000 HP four-stage, Class FE-44 compressor

Life on the Chemical Newsfront



THE FIRST DECADE is over for wonder-working AUREOMYCIN® *chlortetracycline*. Since being introduced by Lederle, AUREOMYCIN *chlortetracycline* and its decendant, ACHROMYCIN® *tetracycline*, have been effective in treating about 100 human diseases. The decade ahead not only promises greater use of these antibiotics for curing human ills but also rapidly expanding acceptance in veterinary medicine and in animal feeding to produce healthier and more productive chickens, cattle and swine.
(Lederle Laboratories Division)

A NEW LINE ON NEW PRODUCTS is just off the press. A complete listing of new chemicals offered by Cyanamid's Market Development Department has been published. Researchers seeking new compounds for new applications or a fresh starting point for synthesis will be extremely interested in this revised, up-to-date edition. These products, from Cyanamid's research and development laboratories, are classified as "commercial," "limited" and "research" — an aid to those wanting answers now and those with an eye to the future. **(Market Development Dept.)**

A NEW EYE ON TEXTILE DYEING—the Microdyeoscope, an instrument with attachments for individual photographs as well as time lapse and motion picture photography, aids the study of the behavior of single fibers, microscopically, under conditions and cycles typical of commercial dyeing procedures. Designed to facilitate the study of the mechanism of dyeing, the Microdyeoscope has shed new light on dyeing processes. It has proved particularly valuable for the rapid evaluation of dyes and dyeing techniques, especially those for the new synthetic fibers. The inventor of this latest model Microdyeoscope, Mr. Henry E. Millson, a Cyanamid scientist, is shown operating the instrument. He recently received the Olney Award of the A.A.T.C.C. in recognition of a lifetime of valuable contributions to the field of dye application to textiles. **(Organic Chemicals Division)**

CH_2CHCN ↑

TiO_2 ➔

OUTPUT DOUBLES AT TWO PLANTS to meet demand for two dissimilar chemicals. *Titanium dioxide*—so inert that its brilliant white opacity is unaffected by weathering or by most chemical environments — is now available in greater quantities from Cyanamid's recently expanded facilities at Savannah, Georgia. *Acrylonitrile*—a highly reactive monomer and intermediate—is the other. The additional output at Cyanamid's Fortier plant in Louisiana will meet the increasing demands for a broadening range of acrylonitrile-based plastics, rubbers and coating resins. In these same areas of application, titanium dioxide finds its major markets as a superior white pigment. **(Pigments Div. and Organic Chemicals Div.)**

CYANAMID

AMERICAN CYANAMID COMPANY
30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.

For further information on these and other chemicals, call, write or wire American Cyanamid Company

Why a Steam Trap Has to Handle "Air"

Low temperatures and corrosion of equipment are often evidence of inadequate trap air venting capacity

Air, with its load of oxygen and carbon dioxide, has an unwholesome habit of interfering with the efficiency of steam heated units. If steam were always free of these undesirable companions, things would be a lot simpler for men-who-operate-plants. Because it isn't, three unhappy situations frequently occur:

1. ***Operating temperatures are subnormal.*** This is a two-part problem. First, an air-steam mixture has a lower temperature than pure steam at the same pressure—see Table A. Secondly, air can "plate out" on heat transfer surfaces as shown in Figure 1. Under some conditions, such an air film will knock down heat transfer efficiency by as much as 50%.

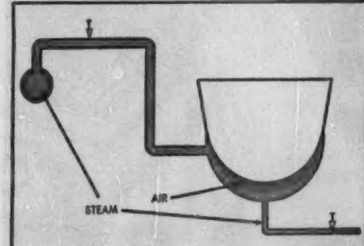


Fig. 1. How air can "plate out" on heat transfer surfaces. This "insulation" drastically reduces heat transfer efficiency. Armstrong trap operation creates turbulence in the equipment that prevents this.

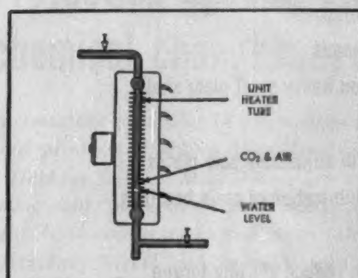


Fig. 2. *Corrosion occurs when units are not kept continuously free of both condensate and air. Armstrong traps discharge both,* at steam temperature, *as fast as they accumulate.*

2. ***Corrosion rears its ugly head.*** Oxygen and carbon dioxide are real trouble-makers. CO_2 gas goes into solution in condensate, forms carbonic acid and chews away at vulnerable metal sections. O_2 aggravates the situation. See Figure 2.

TABLE A—How air reduces steam temperature.

Gauge Pressure	Temp. of Steam with No Air Present	Temp. of Steam Mixed With Various Amounts of Air (% Air by Volume) 10%	30%
10.3	240.1	234.3	220.9
25.3	267.3	261.0	246.4
50.3	298.0	291.0	275.1
75.3	320.3	312.9	295.9
100.3	338.1	330.3	312.4

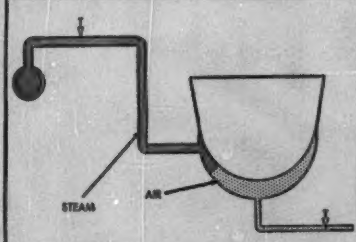


Fig. 3. *When steam is turned on, it takes a trap with extra air venting capacity to provide fast heat-up.*

3. ***Heat-up is slow as a snail.*** Air has a picnic in units that are shut off periodically. Figure 3 pictures the problem. Lines and equipment literally fill up with air. When the steam is turned on it can get in only as fast as the air gets out.

Enter Steam Traps

Curing these steam system ailments involves an operation sometimes called a "trap transplant." It consists of removing traps that don't get the air out and replacing them with traps that do.

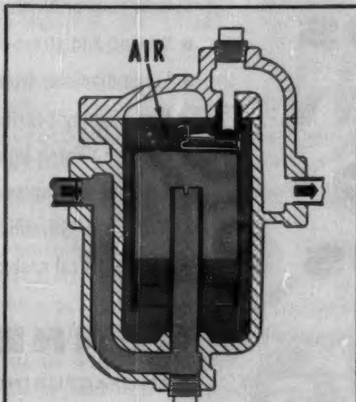
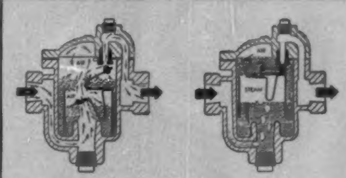


Fig. 4. *Air entering an Armstrong trap passes through the bucket vent and accumulates in the top of trap. When trap opens, air is discharged along with condensate.*

Figure 4 shows how an Armstrong inverted bucket trap continuously vents air. What the picture doesn't show is a built-in plus-value of this trap's design. An Armstrong trap opens suddenly, creating a momentary pressure drop and turbulence in the unit being drained. This breaks up air films and "pumps" air down to the trap so it can be vented.

The vents in standard Armstrong trap buckets will pass all the air normally encountered. In special cases, such as paper machine dryers, the vents are correctly sized larger at the factory to meet the requirement.



Thermostatic vent open. *Thermostatic vent closed.*

Fig. 5. *Open float with thermostatic vent for off-and-on units. When trap is cold, vent is open, permitting air to blow through when steam is turned on. When steam reaches trap, heat closes thermostatic vent. Then, regular bucket vent handles all air coming in with steam.*

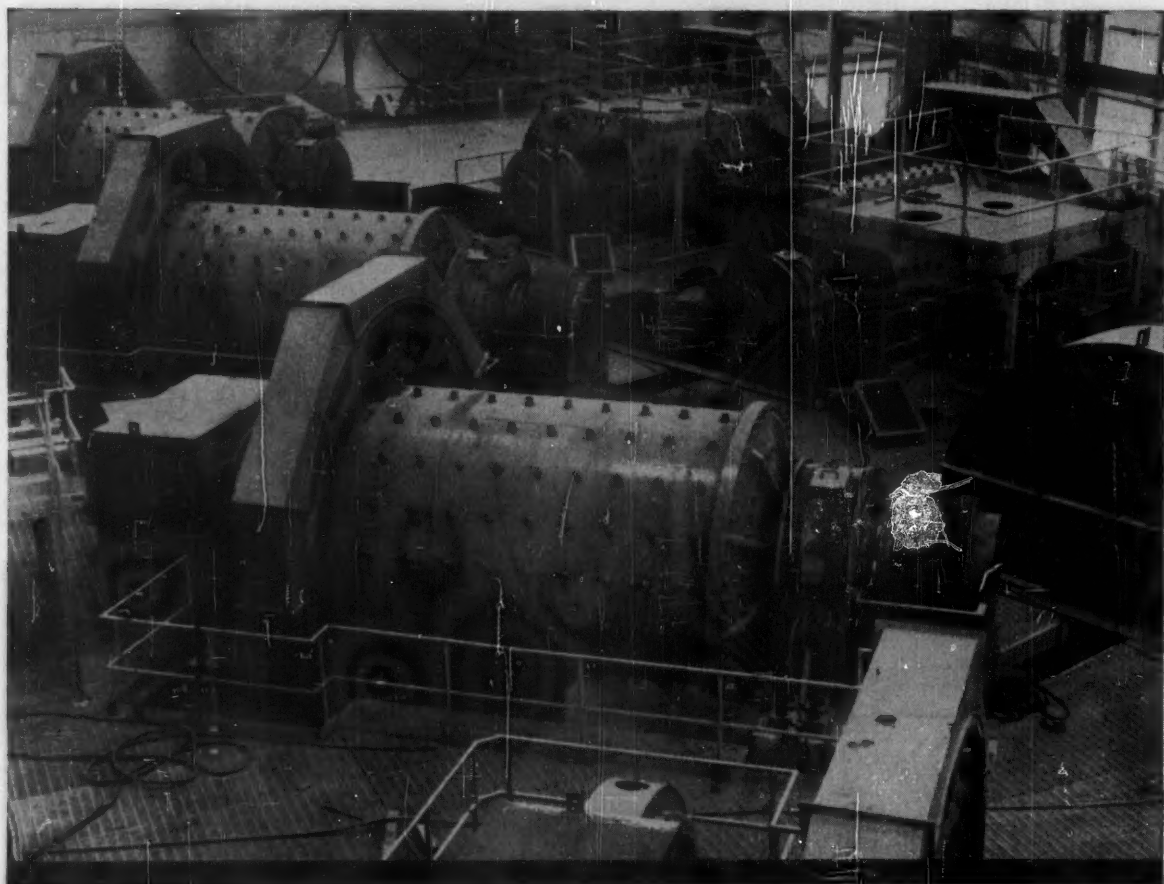
Open Float with Thermostatic Vent

Super air-venting capacity is a must for fast heat-up of low pressure unit heaters, heating coils, steam headers and other units that are on-and-off. Figure 5 shows how the Armstrong open-float-with-thermostatic-vent trap takes care of this.

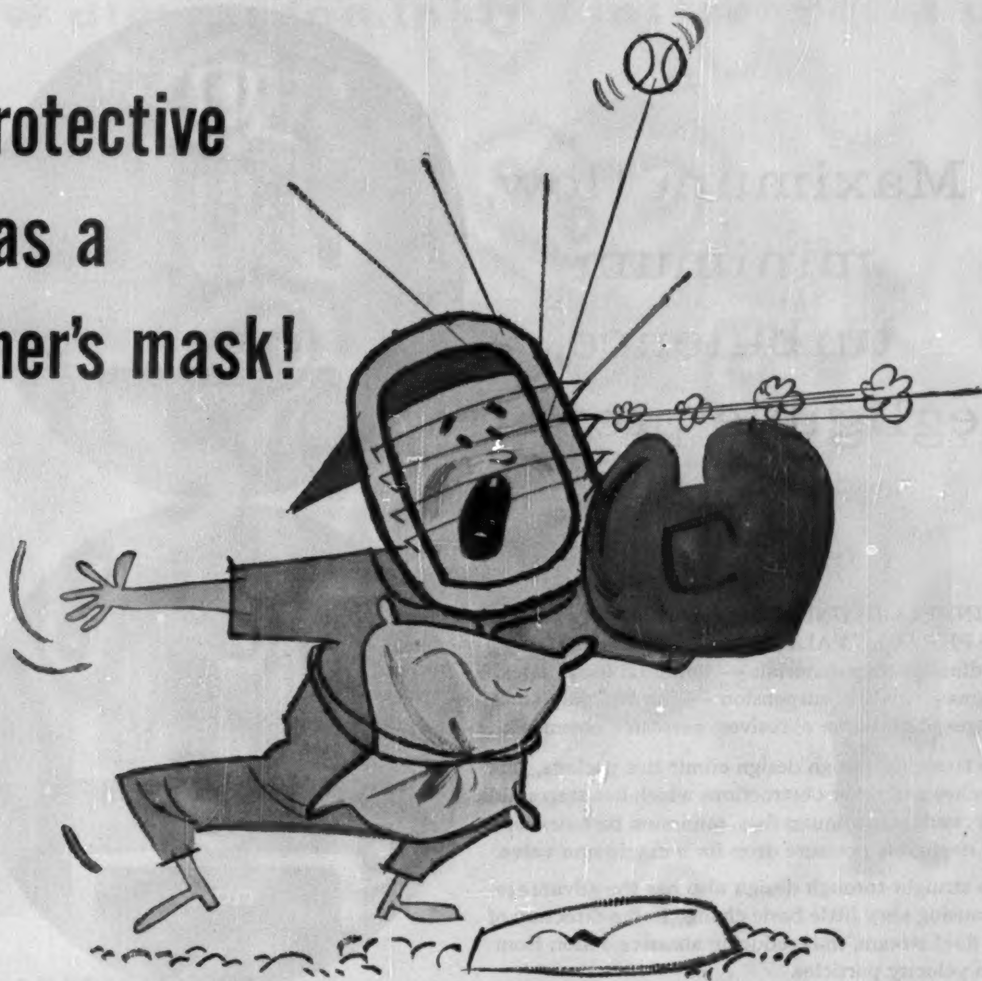
* * *

The 44-page Armstrong steam trap book covers other features of the Armstrong trap as well as its excellent air handling characteristics. This catalog also discusses trap selection, installation and maintenance. Your local Armstrong Representative or Distributor will be glad to give you a copy. Call him, or write Armstrong Machine Works, 8587 Maple Street, Three Rivers, Michigan.

ARMSTRONG STEAM TRAPS



as protective as a catcher's mask!



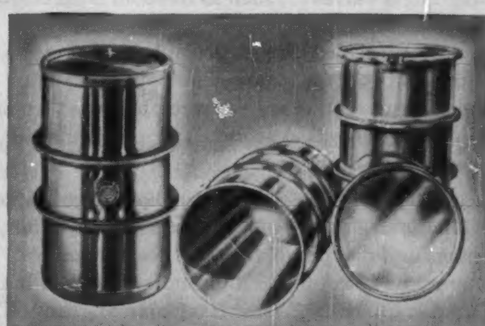
Protection against product discoloration... chemical changes... corrosive action

Is container neutrality of prime importance in shipping or storing your products? *Hackney Alloy Metal Drums* offer a proved solution.

Hackney Stainless Steel Drums are widely used to ship and store nitric acid, phosphoric acid, acetic acid, solvents formaldehyde, inks, food concentrates and many other products.

Hackney Nickel and Monel Metal Drums are frequently used to transport and store products such as phosphorous trichloride and other chemicals required for shipment in ICC-5K nickel drums. Monel drums are used primarily for shipment of liquid bromine.

Hackney Metal Drums are available with plain sides or I-bar rolling hoops; welded chimes; smooth bottoms with substantial foot rings; crack- and crevice-free, easy-to-clean interiors.



Stainless steel drums, with removable heads, come in 30- and 55-gallon capacities; drums with tight heads, 55-gallon capacities. For specifications of stainless, nickel and Monel drums, write:

Pressed Steel Tank Company

Manufacturer of Hackney Products

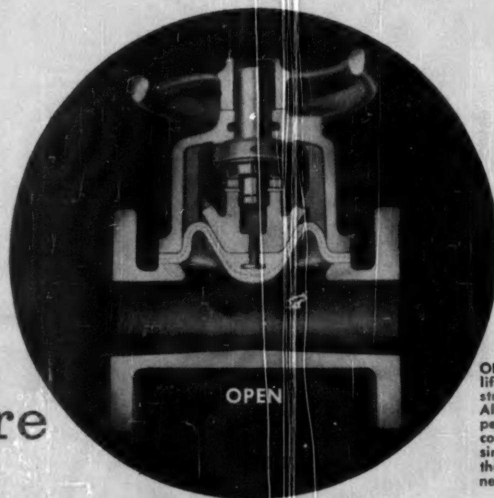
1447 South 66th Street, Milwaukee 14, Wisconsin

Branch offices in all principal cities

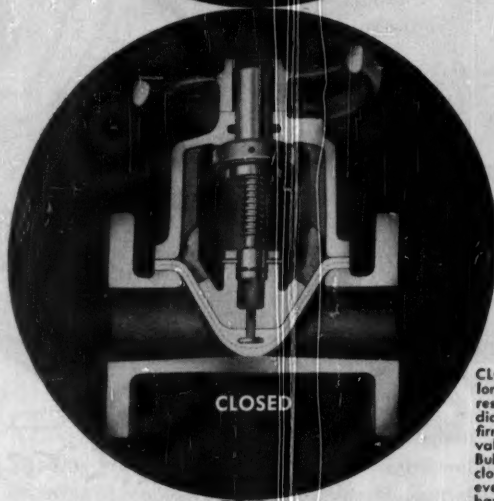
Hackney

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

Maximum flow, minimum turbulence, negligible pressure drop!



OPEN Diaphragm lifts high for streamline flow. Also, valve design permits comparatively simple rodding through, when necessary.



CLOSED Despite long usage, resilient diaphragm seals firmly against valve body. Bubble-tight closure is assured, even when handling gritty or fibrous materials.

GRINNELL-SAUNDERS STRAIGHTWAY DIAPHRAGM VALVES* are unsurpassed for handling viscous materials — semifluid foods, latex, magmas; solids in suspension — slurries, pulp stock, sludges; fluid-borne abrasives; corrosive chemicals.

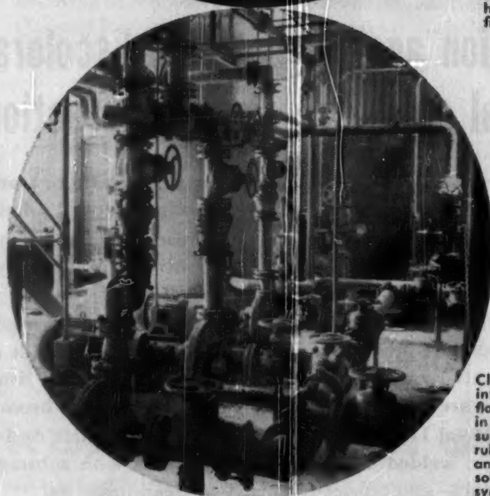
The straight-through design eliminates pockets, gate trenches and other obstructions which can trap solids. The result is maximum flow, minimum turbulence, and negligible pressure drop for a diaphragm valve.

The straight-through design also has the advantage of causing very little basic change in the direction of the fluid stream, thus reducing abrasive action from high velocity particles.

These advantages are in addition, of course, to benefits normally associated with the use of diaphragm valves . . . such as freedom from corrosion and clogging of working parts, since these are completely sealed off by the diaphragm; prevention of product contamination; elimination of stem leakage and routine maintenance, because there are no packing glands. Also, when properly pitched, lines are self-draining.

Grinnell-Saunders Straightway Diaphragm Valves are available in a choice of body sizes and materials, linings and diaphragms. Handwheel or power operated. For complete information, write Grinnell Company, Inc., 277 West Exchange St., Prov. 1, R. I.

*Patented



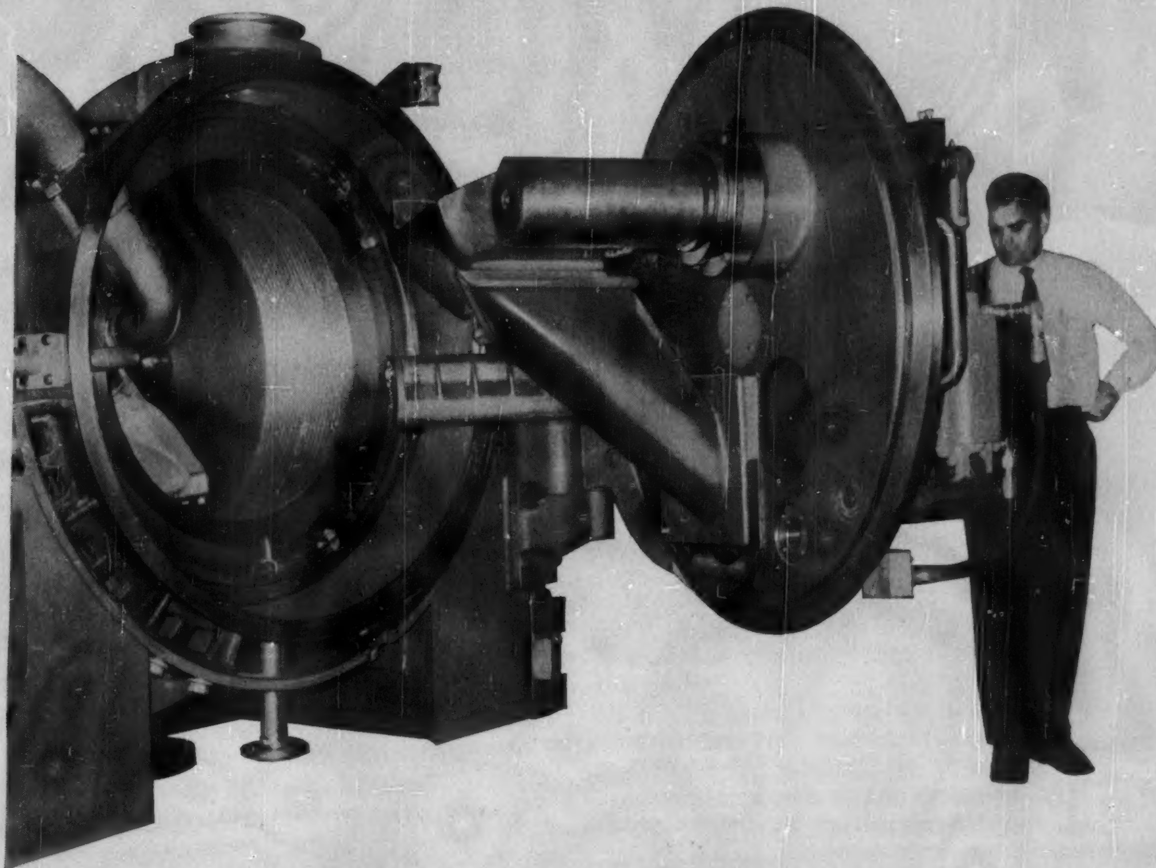
Clogging and interruption to flow is prevented in lines handling a suspension of rubber particles in an acid brine solution at this synthetic rubber plant.

GRINNELL-SAUNDERS DIAPHRAGM VALVES

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

a new dimension in crystal dehydration



CAPACITIES OF THE NEW SHARPLES C-41 SUPER-D-HYDRATOR ON REPRESENTATIVE SLURRIES.

AMMONIUM SULFATE — a relatively large free-draining inorganic crystal . . .
20-24 tons/hour

"CAUSTIC SALT"—a relatively small, slower draining crystal requiring high efficiency rinsing . . .
13-16 tons/hour

POLYPROPYLENE—typical of extremely fine, slow draining, low bulk density organic solids . . .
1.0-2.5 tons/hour

The C-41 Super-D-Hydrator is the largest of 3 high efficiency crystal drying centrifuges by Sharples (C-20;C-27;C-41) which are designed for both atmospheric and pressurized operation, and are available in various standard materials of construction.

Sharples engineers have incorporated many innovations in the design of the new C-41, learned in over 40 years experience in the chemical industry, and are further prepared to give special design consideration to each specific problem. May we consult with you regarding your separation problems?

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Chementator

C. H. CHILTON

Electrolytic refining of titanium reached advanced pilot-plant stage this month when Bureau of Mines, Boulder City, Nev., put on line a new 10,000-amp. cell with capacity of 400 lb./day. Feed will be unalloyed scrap and off-grade sponge.

Pocatello court has thrown out Central Farmers' counterclaim charging Monsanto with attempts to monopolize the field of elemental phosphorus manufacture (Chementator, Oct. 6, p. 48). Court says CFF's argument wasn't "technically appropriate."

New salary requirements for exemption from overtime pay go into effect on Feb. 2. Administrative and professional employees must be paid at least $95/week to be so exempt, vs. $75 now required. Special exemptions for shortened duty will require $125/week minimum vs. $100 now.

Three refiners vote for Penex process

Isomerization of straight-chain C_5-C_7 paraffins—long touted as the next major process route to higher octanes—now has three backers:

• Phillips reports successful operation of its 34,000-bbl./day pentane unit at Borger, Tex. (*Chem. Eng.*, Dec. 1, p. 60).

• Atlas Processing Co. last month started up a new unit at Shreveport, La., to isomerize 3,800 bbl./day of hexane.

• Gulf Oil has started building a unit at Port Arthur, Tex., for isomerizing 10,000 bbl./day of pentane.

Although a number of various isomerization processes have been developed to the point of being offered for licensing, only Universal Oil Products' Penex process has so far made the grade commercially. Phillips and Atlas are both using Penex. And while Gulf calls it process "hydroisomerization" to distinguish it from Penex, the company gives UOP partial credit in its development.

Gulf, incidentally, says that it will be first to use platinum catalyst for isomerizing pentanes, indicating that Phillips' pentane operation is probably using some other catalyst of Phillips' own choosing.

Superphos acid to get U. S. producer

Superphosphoric acid, pioneered by Tennessee Valley Authority chemical engineers, will soon go commercial in the U. S.

Central Farmers Fertilizer Co. now plans to convert elemental phosphorus from its new 35,000-kw. electric furnace plant at Georgetown, Idaho, into super acid. Canada's Electric Reduction Co. began similar operations earlier this year. TVA has also been supplying demonstration quantities to the fertilizer industry (*Chementator*, Oct. 1957, p. 137).

More concentrated (76% P_2O_5) than ordinary furnace acid (around 54% P_2O_5), superphosphoric acid can be produced at a cost not significantly greater per unit of P_2O_5. In gen-

eral, the same kind of plant is used. And lower operating temperature (155 vs. 212 F.) decreases corrosion of equipment.

Super acid offers a big potential advantage in lower shipping costs. Phosphoric acid above 58% has previously been classified as "food-grade," which ships at rates about twice as high as low "fertilizer-grade" concentrations. TVA has been fighting to get super acid carried at fertilizer acid rates. This fight has been only partially successful; Southern railroads decided in September that super acid should get a lower rate than food-grade, but higher than fertilizer-grade in direct proportion to its P_2O_5 content.

Freight cost is highly important to Central Farmers, whose outlets are in the Midwest. CFF first planned (*Chementator,* May 1957, p. 144) to convert its furnace phosphorus into calcium metaphosphate (a high-P_2O_5-content solid) to save on shipping costs, then process cal meta into high-analysis mixed fertilizers in the Midwest. Technical difficulties are holding up this program.

Instead, CFF will convert its phosphorus into high-analysis superphosphates via the super acid route, begging the question—for the time being, at least—of freight rates.

How to make modernization pay off

Operating employees at Anaconda's electrolytic zinc plant—first refusing to go along with company plans to boost productivity—quickly changed their tune when the company announced that production would be transferred to another plant.

In order to put its zinc operations at Anaconda, Mont., on a more competitive basis, the company recently installed labor-saving air hoists in the tank house and asked the operators to strip 18 tanks of cathodes per shift instead of 12. The union (Mine, Mill and Smelter Workers) refused. Anaconda then announced that zinc operations would be transferred to its Great Falls plant, where production costs are much lower. Some 250 employees would have been affected.

Two days later the union voted 35-20 to strip 15 tanks per shift for a 30-day break-in period, then increase output to 18 tanks. Anaconda immediately reversed its earlier decision to shut down the plant.

Meanwhile, in Alcoa, Tenn., Aluminum Co. of America is negotiating with United Steelworkers over similar problems. Productivity at the Tennessee plant is lower than at the company's newer smelting plants. However, the older plant has carried out a constant program of modernization which, the company feels, justifies improved productivity.

The union disagrees and has threatened to strike. Although admitting the possibility of moving operations elsewhere, the company expects to reach an amicable settlement.

Gas turbines score economic coup

The combustion gas turbine as a prime mover is now competing with steam turbines and electric motors at Esso Standard's Bayway (N. J.) refinery.

Esso operates three dual-shaft, 9,000-hp., Clark Bros. gas turbines, all driving centrifugal compressors. Two are on an ethylene unit, burning 600-Btu./cu.-ft. process tail gas. Another, on a Powerformer unit, uses 500-Btu. process tail gas. The turbines, however, can handle any gas of 500-2,500 Btu./cu. ft. heating value or can even be modified to use liquid fuels.

Large-scale process uses of gas turbines to date (e.g., Houdry fixed-bed catalytic cracking, nitric acid manufacture) have taken advantage of the availability of hot combustion products from the process. Such gases have little or no fuel value; their recoverable energy content is due to their sensible heat and pressure level.

Esso sends the hot (875 F.) turbine exhaust gases to coolers, where they generate steam for the refinery grid. This boosts overall thermal efficiency from a nominal 18% to about 75% and helps swing the economic balance toward the combustion gas turbine as a prime mover.

Spotlight on soda ash from trona

Word that Diamond Alkali is exploring trona beds in Wyoming's Green River Basin suggests that this low-cost source of soda ash, despite its distance from large markets, offers the alkali industry an attractive alternative to major expansion of the ammonia-soda process.

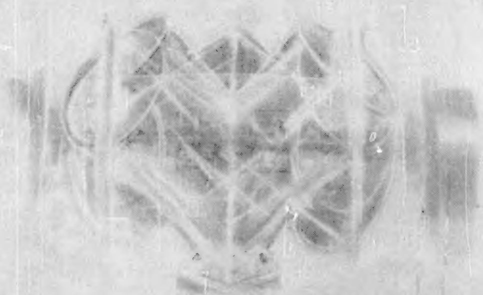
Food Machinery & Chemical has been producing soda ash from Wyoming trona since 1953. Initial capacity of 1,000 tons/day will be boosted 20% when additional facilities now

(Continued on page 22)

ENTIRELY NEW PRINCIPLE enables you to...

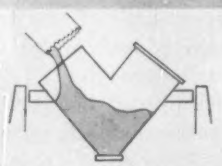
Blend

liquids and solids intimately in one operation

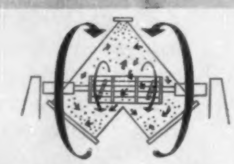


It is now practical, with the P-K "Twin-Shell"* blender, to blend many difficult formulations that have heretofore been either impossible or impractical because of the number of separate operations required to achieve a desired product. With the new "Twin-Shell" blender, liquids, solids, clumpy and crystalline materials can all be intimately blended in one operation. Average blending time: 5 to 15 minutes. The P-K "Twin-Shell" blender is unlike any other blender. It works on an entirely new blending principle. Here, in diagram, is how it works.

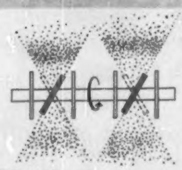
*Patented



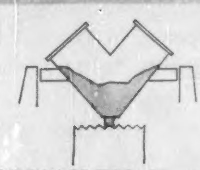
CHARGE DRY SOLIDS through top of either shell. Optimum charge level for most materials is about 65% of total shell volume.



TUMBLE AND AERATE. As shell revolves, rapidly spinning wire cage intensifier breaks up agglomerates, literally creates dust storm in material.



ADD LIQUID. Centrifugal force sprays atomized liquids from periphery of control discs on Liquid-Feed Bar into finely dispersed solids.



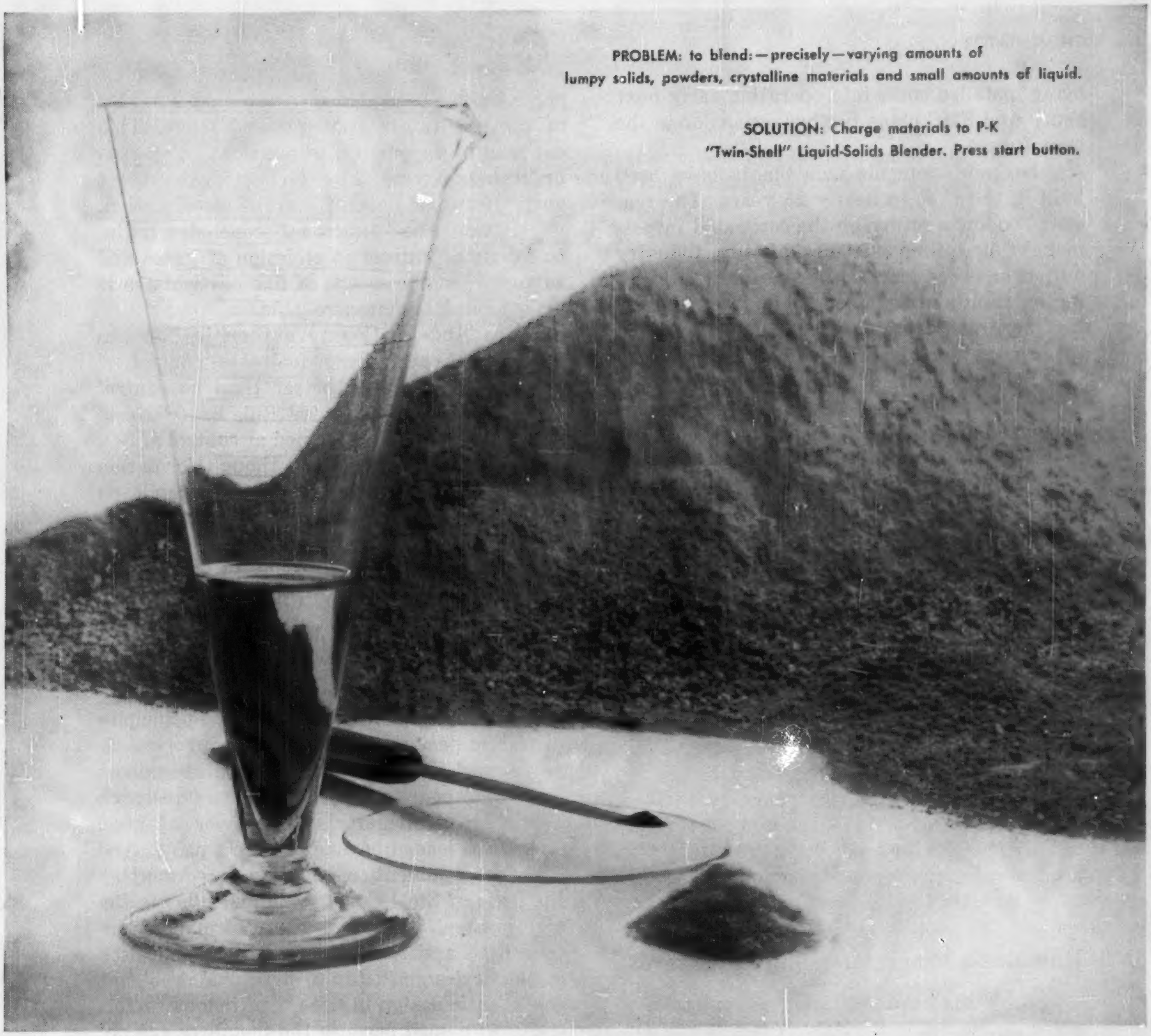
DISCHARGE PRODUCT easily through apex of shells. Accessibility of interior and easy removal of Liquid-Feed Bar speed cleaning.

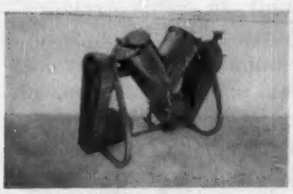
Get new ideas for your blending process at P-K's pre-test lab

Complete, scientific investigation of all types of blenders now available at Patterson-Kelley.

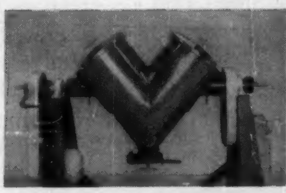
Blending of complex formulations is full of variables. The equipment and procedure that are ideal for one combination of ingredients may be unsatisfactory for another. Proper selection of equipment demands thorough scientific investigation. You can conduct your investigation at Patterson-Kelley's Customer Pre-Test Lab, at East Stroudsburg, Pennsylvania. Since P-K makes practically all types of blenders, you can run conclusive comparison tests with your materials. Trained technicians will help you.

To set up an appointment, just place a collect call to Russell Dotter at Patterson-Kelley. Tel. No.: Stroudsburg 820. He'll be happy to tell you how much of your materials to bring and to give you other details. East Stroudsburg, in the Pocono Mountains, is just 2 hours from New York City, easily accessible by all carriers.



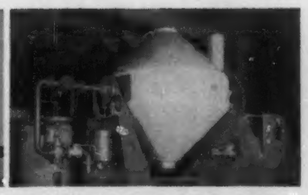


"TWIN-SHELL" Liquid-Solids laboratory models are made in transparent Lucite or stainless steel, in 8 and 16 quart sizes.



PRODUCTION MODELS of the "Twin-Shell" blender range up to 50 cu. ft. capacity. (Intensifier and Liquid-Feed Bar optional.)

VACUUM TUMBLE DRYERS by Patterson-Kelley are available in sizes down to the standard 1 cu. ft. capacity lab model.



PRODUCTION MODELS of the Vacuum Tumble Drier have capacities up to 150 cu. ft., come factory aligned, piped, instrumented.

BLENDER LITERATURE. Specialized information and data in greater detail are given in two Patterson-Kelley publications: Bulletin No. 16, Chemical Process Equipment and Bulletin No. 15A-1, Twin-Shell Laboratory Blenders. Write for your copies today. Patterson-Kelley Company, Chemical and Process Equipment Division, 1512 Hanson St., East Stroudsburg, Pa. 15

Patterson Kelley

Chemical and Process Equipment Division

being installed come into operation early next year, And FMC plans further expansion in the near future.

No new ammonia-soda plants have been built in the U.S. in nearly 25 years. The reason: Too low a return on the estimated investment of more than \$30,000/daily ton. Industry output has been increased, instead, by expanding existing ammonia-soda plants, by recovering more ash from Searles Lake brines and by carbonation of surplus caustic soda.

FMC's answer: Mining of solid trona (sodium sesquicarbonate) 1,500 ft. underground, hauling it to the surface, processing it to soda ash (*Chem. Eng.*, May 1953, pp. 118-120). Capital investment in mine and surface plant together is only about half that of an ammonia-soda plant. Operating costs are less, too.

Offsetting these advantages to some extent are freight costs. Also deterring prospective trona miners are the twin problems of getting options and proving out deposits.

But the balance would swing even more towards trona if fluid mining methods (similar to salt-brine wells) could be perfected. Don't be surprised if FMC comes up with such a development shortly. Two years ago (*Chem. Eng.*, Dec. 1956, p. 118) the company began testing the idea in a big way, predicting that process refinements would soon make the technique feasible.

How dusts synergize pollution hazards

Problems in air-pollution control take on a new dimension in the light of recent evidence that some gaseous pollutants are dangerous to the body only when associated with finely divided solids.

As D. A. Irwin, Alcoa's medical director, pointed out to the Manufacturing Chemists' Association last month, "An industry contributing only inert, nontoxic fine-micron particulate matter to the air may be just as responsible for adverse health effects as the industry contributing small amounts of a toxic gas, although singly these materials would cause no adverse effects."

Irwin explains that water-soluble gases and vapors in the air do not ordinarily reach the lungs; they are scrubbed out in the upper respiratory tract. On the other hand, many air-borne solid particles under 5 microns do reach the lungs. Gas or vapor can be adsorbed on the solid particles and liberated when the particles are deposited on the moist surfaces of the respiratory passages and lungs. This can lead to serious bodily reactions—impaired breathing, extra load on the heart, even direct entry of a toxic irritant into the blood stream.

It would be "ludicrous," concludes Irwin, to set rigid controls on emission of gases and vapors when the escape of fine particulates is uncontrolled or uncontrollable.

Los Angeles County authorities, on the other hand, apparently feel that control of gaseous pollutants is better than no control at all. Its recently adopted Rule 62 (*Chementator*, Dec. 15, p. 65) is aimed at control of SO_2 emission from stacks, even though formation of dreaded acid smog admittedly depends on coexistence in the atmosphere of submicron particles of nucleating materials.

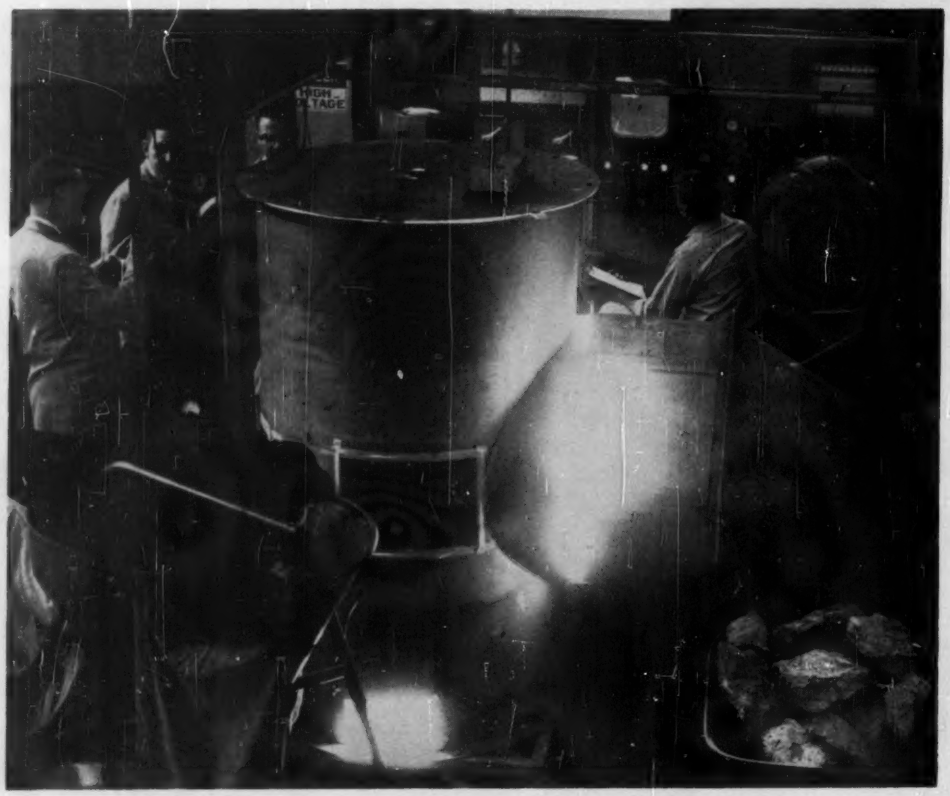
Cheaper structures via plastic design

Lower-cost steel structures, designed in less time and using 15-20% less material than conventional structures, will be possible through better understanding of the principles of plastic design.

American Iron & Steel Institute members last month heard a report on 12 years' research at Lehigh University on behavior of steel structures loaded beyond the yield point. And due for imminent publication by American Institute of Steel Construction is "Plastic Design in Steel," first of a group of manuals intended to assist engineers in the application of plastic design theory to structural problems.

Plastic design utilizes "continuous" structures, so named because the members are not free at the supports but are joined, as by welding, into a continuous unit. In such a structure every member contributes to the strength of the whole. Thus a single member may be stressed beyond its yield point but, instead of failure of the member as in a discontinuous structure, the stressed member draws on the reserve strength of the other structural members. In other words, criterion of plastic design is the ultimate load the structure will carry, as distinct from the point of first yield.

Although plastic design is not new, having been applied widely in Europe, American designers have shied away from the rigorous, complex design calculations involved. However, the work at Lehigh has now come up with simplified concepts which make plastic design faster than conventional elastic design and no less accurate.



INTENSE 13,000-18,000-F. heat from arc radiates from Vitro's manganese-process chamber.

Intense Arc Pierces Temperature Barrier

Producing temperatures at the 15,000-30,000-F. level, the high-intensity electric arc opens a completely new environment that engineers are now exploiting.

Raise your sights when you think of high process temperatures. Once limited by available heat sources to temperatures below 10,000 F., engineers now process materials at the 15,000-30,000-F. level attained with high-intensity electric arcs.

Four major developments now use this type of arc to provide high-temperature levels. Using this tool, engineers:

• Decompose or combine at ultra-high temperatures materials whose molecules are unreactive below 10,000 F.

• Spray-coat surfaces with refractory materials such as tungsten (m.p. 6,430 F.), columbium (m.p. 4,642 F.) and molybdenum (m.p. 4,748 F.). And spray-fabricate these same refractories into shapes needed for space-travel components.

• Fuel space vehicles with metals to be ionized and magnetically thrust from a space-vehicle's propelling chamber.

• Reproduce rocket-re-entry conditions to test new materials of construction for space age.

▶**Source of Heat**—Once used only to illuminate searchlights and projectors, the high-intensity electric arc makes possible all these developments.

Arc attains its useful energy concentration when current feeding the anode exceeds a critical level. Resulting arc-density has more heat energy than can be radiated or conducted from the anode tip. Excess energy is consumed as heats of vaporization and ionization by anode or other materials placed near anode.

Too, resulting energy-bearing

Bright, true colors made from dye intermediates purified with

DARCO®

What product, famous for purifying chemicals by *removing* color bodies, also helps *keep* colors bright and true . . . by purifying a *colorless* chemical?

The answer, of course, is DARCO Activated Carbon. Seems that dye intermediates, which may be colorless themselves, contain impurities that could cause false or muddy colors in the finished dye. Intermediate makers find that DARCO does a first-class job of adsorbing these impurities, preventing unwanted side reactions. They like DARCO's low product retention too, because they get high yield along with efficient purification.

If you've got a purification problem, try adsorption with DARCO. It has helped chemical manufacturers get rid of color bodies, odors, colloids, floc-precursors, causes of haze and foam, and other adsorbable impurities for over 40 years. We'll be glad to talk over your application and show you how economically attractive DARCO purification is. Call or write us today.

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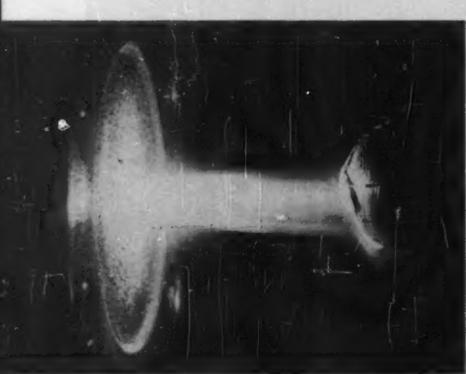


PLASMA spray-coats refractory to protect surface of part.

CONE in plasma undergoes simulated re-entry to earth's air.

positive ions are forced radially away from anode tip, forming the high-velocity, high-temperature plasma jet (tail flame) that proves so useful.

▶**Refining On Atomic Scale**—Development work, just completed by Vitro Laboratories, Div. of Vitro Corp. of America for the General Services Administration, proves the feasibility of high-intensity-arc (Hierarc) refining of manganese-rich, Colorado rhodonite ore.

U. S. Manganese Corp., formed by Vitro, Sheer-Korman Associates* and Great Divide Mining and Milling Corp., plans to upscale successful pilot plant to a Mn-from-rhodonite production facility. When this takes place, the U. S. will no longer have to depend heavily on Indian and Brazilian manganese-ore resources.

Rhodonite ore, largely manganese silicate, once required costly, multiple recycle processing to separate manganese from silica. Vitro's Hierarc process accomplishes separation in one step, expends only 2.5 kwh./lb. of processed ore.

Rhodonite is first milled and blended with carbon (15-25%). Extrusion press shapes blend into 2-in.-dia., 44-in.-long anodes. Tunnel kiln bakes shaped anodes for 12-20 hr. at 1,650-1,830 F.

▶**Ionizes Continuously**—Anode feeds into Hierarc continuously at 103 in./hr. (24 lb./hr.) rate and vaporizes and ionizes at 13,000-18,000 F.

Charged silicon, manganese and other particles travel length of tail flame into cooler region (4,500 F.) where SiO_2 and MnO precipitate. Air swept into arc, provides excess oxygen for the reaction, quenches arc-product gases and transports product to bag collector. Subsequent leaching recovers pure manganese from this SiO_2-MnO mixture.

Upscaled version of Hierarc process will use 6-in.-dia. or larger anodes and will consume less power per pound of Mn produced.

Just another among many applications of Hierarc, piloted at Vitro, is the halogenation of boron to produce boron halides. Halogen gas is piped from cylinders into Hierarc plasma where it reacts with boron from vaporizing anode. This might be applied to the production of high-energy fuels used in jet aircraft.

▶**Coating and Fabricating**—Meeting demands for refractory coatings and fabricated shapes to withstand unusually severe rocketry conditions, several companies now offer plasma-coating and fabricating devices or services. A high-intensity arc generates the required plasma.

Just last month, Linde Co., Div. of Union Carbide Corp., announced its entry into the plasma-jet business, now offers plasma-spray coating and unique fabricating services. (See *Chem. Eng.*, Dec. 15, 1958, p 67).

Giannini Plasmadyne Corp., Santa Ana, Calif. and Thermal Dynamics Corp., Hanover, N. H. sell plasma-generating devices. Giannini pioneered plasma spray coating.

Refractory materials in the form of wire or powder feed into plasma stream and vaporize. Objects placed in refractory-bearing stream condense refractory on their surfaces.

Plasma-jet coating makes possible application of materials such as zirconium diboride on jet-engine parts. Such coatings must resist high-temperature erosion from combustion products of high-energy fuels. Too, high-temperature materials such as tungsten, molybdenum, palladium, metallic oxides and cermets may be applied to nose-cones and other external components of rockets.

Linde's new fabrication technique coats desired refractory material on a brass mandrel within 0.001 in. of desired thickness. By dissolving mandrel in acid, Linde comes up with finished shapes which often cannot be made any other way. One example of this was recent fabrication of tungsten nozzles for rockets.

▶**Testing Missile Materials**—High-velocity plasma jets are simulating rocket re-entry conditions in hypersonic wind tunnels set up by General Electric, Linde and others.

A wedge of material placed in the plasma jet's path reveals its resistance to:

- Wide range of temperatures up to 15,000 F.
- Ultra-high gas velocities. Vitro considers it theoretically possible to reach Mach 100 at 0.1 mm. Hg; Linde and G.E. already have attained Mach 2-3.
- Intense radiation density invisible through ultra-violet spectra.
- Superfine abrasive dust (depending on anode material).

Severe re-entry conditions,

* Dr. Charles Sheer, Chief Scientist at Vitro Laboratories, and Dr. Samuel Korman did much of early work on Vitro Hierarc.

particularly in the ionosphere, present a real challenge to materials-selecting chemical engineers. Nose-cone materials must withstand thermal shock, ion bombardment, high-intensity radiation and erosion due to high-velocity dust particles or gas.

▶ **Propelling Rockets, Too**—Several companies under U. S. Air Force contracts now are studying use of electromagnetically accelerated ion flow to propel missiles through space.

Rocketdyne Div., North American Aviation Corp., began operation of a laboratory last month to test their first ion-engine for missiles.

Vaporized cesium, sodium or rhubidium metal ionizes when fed into a high-intensity arc housed in a charged chamber. Electrostatic field then forces ions out of ionizing chamber through a 2-ft.-long, 9-in.-dia., cylindrical thrust-chamber.

Although effective velocity of ions is 300,000-400,000 mph., thrust is relatively low. Therefore, ion engine will propel missiles only after they have left the earth's gravitational field.

Other companies actively working in this field are Vitro Laboratories, General Electric, Giannini Research, Aerojet-General, Republic Aviation, Goodyear Aircraft and Avco Research.

New Kraft Pulp Process Available to Industry

Patented Sutherland process for making high-yield, high-strength kraft pulps by refining in hot black liquor was recently signed over to the public domain by the Black-Clawson Co.

Process (U. S. 2,591,106 issued to Daniel M. Sutherland) fiberizes coarse, partially cooked pulp suspended in black liquor by passing through Sutherland disk refiners located between the vertical blow tank and pulp washers. Short cooking time gives greater yield of fiber from the wood chips, but requires the positive action of the disk refiner to free all the fibers. Following fiberizing step, pulp is washed and processed by conventional methods.

Process is now being used in several kraft pulp mills under Sutherland license. Black-Clawson had acquired the U. S. rights to the process and is the marketer of the Sutherland refiner.

Water Models Used to Design Turbines, Too

Model studies, in which water flow simulates air flow, is becoming an increasingly popular tool for the design engineer (*Chem. Eng.*, Oct. 20, 1958, p. 70). Westinghouse is the latest firm to employ this technique, using it to perfect designs for steam turbine blades, large fans and other rotating equipment.

Firm lists two major reasons for going to the water models: First, flow patterns in water models are more visible than in wind tunnels. Second, water being denser than air, identical flow patterns are produced with only one-thirtieth the velocity.

Here's how Westinghouse's water tunnel works: Tunnel itself is a vertical pipe, 2 ft. dia. and 20 ft. high. One section is made of clear plastic in which the model is mounted. A 7.5-hp. motor rotates the model while water flows past at an 8,000-gpm. rate. Stroboscopic flash unit photographs the flow patterns, made visible by injecting air bubbles, oil droplets or small plastic particles into the water stream.

A 30-hp. centrifugal pump circulates 13 tons of water through the system. Temperature of water in the tunnel can be varied from room level to 150 F.

Atomic Tempo Quickens In Design and Building

In quick succession over the past few weeks, new developments have been announced in construction and design studies for nuclear reactors.

• Philadelphia Electric Co., spearheading a phalanx of more than 50 private utility companies, has submitted to the Atomic Energy Commission a proposal to design and build a big, high-temperature, graphite-moderated, helium-cooled nuclear power plant.

The $24.5-million plant, to be completed in late 1962 or early 1963, would have a capacity of 40,000 kw. and produce steam at 1,000 F. and 1,450 psi.

• In another move, AEC approved a design study proposal of Puerto Rico Water Resources Authority for a boiling-water power reactor with a nuclear-fired superheater to boost steam temperatures.

Higher steam temperatures and better plant efficiency would mean expected reductions in unit capital cost and fuel costs.

• On still another front, AEC announced that it will license National Aeronautics and Space Administration for a low-power reactor at Lewis Research Center near Cleveland, Ohio.

Facility will be a zero-power homogeneous research reactor using uranyl fluoride-water solutions as fuel.

Philadelphia Electric Co.'s plant would be built in two stages to meet the limited time schedule set by the U. S. government. Initially, reactor would have metal-clad fuel elements containing homogeneous carbon compacts of uranium (U-235) carbide and thorium carbide, and would produce 30,000 kw. from 840-psi. steam at 850 F. Later, the reactor would use graphite-canned fuel elements.

Conceived by General Atomic Div. of General Dynamics, plant would be built by Bechtel Corp. Westinghouse would be responsible for electric generating system, including the turbine and associated equipment.

The proposal indicated that a 325,000-kw. plant of this type could produce power competitively in many areas of the U. S.

Four-minute CONFERENCE between engineer Bob Christopher and Information Center's Bob Pratt (right) fixes Uniterm language for search, kicks off sequence on next page . . .

Information Retrieval Finds It in Minutes

System at M. W. Kellogg's Information Retrieval Center cuts to minutes the searching time for valuable company documents and boosts engineers' efficiency.

"If you look at it just from the standpoint of how many IBM cards you have, you get a false picture."

So admonishes soft-spoken Bob Pratt, who's supervising M. W. Kellogg's growing information-retrieval system.

"The most important thing," he continues, "is to design information retrieval to meet your needs. What we want is a flexible system, and one that gives us all the important information in the shortest time. For example, we're set up now to do in 15 minutes a literature search that previously would have taken anywhere from one hour to three or four days."

Thus, he capsulates the thinking that has guided Kellogg's information-retrieval center over the past two and a half years, and made it one of the first companies to establish such a setup to handle primarily literature generated within the company.

▶ **A Corporate Memory**—Basic purpose of an information-retrieval center, as Pratt sees it, is to serve as a "corporate memory" retaining vital information from Kellogg's vast research and engineering activities. Eventually, this memory will extend to other divisions such as sales. Of course, information-retrieval center now taps this memory for all Kellogg's activities.

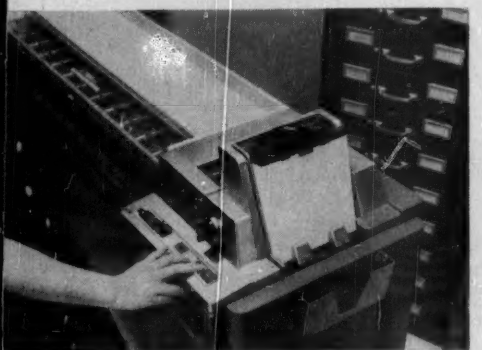
Key to an effective system—one that gives quick, easy access to pertinent information—Pratt asserts, is flexible filing and retrieval and proper selection of documents to "commit to memory." Thus, at Kellogg, a document is given a number of "key words" coded into IBM cards, by which it can be retrieved. Key words can be added or changed, and only documents of long-range value (5-15 yr.) are processed for retrieval.

At present, using no more than 5,000 IBM cards, Kellogg has access to 50,000 documents in its retrieval system, covering 1940-1958. Kellogg now files a total of about 1,000 documents per month; about one-third to one-half of these are processed for information-retrieval center. Generally, the engineer who writes a report (or perhaps gets it from a customer) is the one who processes it. Pratt checks and coordinates.

▶ **A Uniterm System** — Among several possible information-retrieval systems (*Chem. Eng.*, Feb. 10, 1958, pp. 84-86) Kellogg uses what's known as a Uniterm system in conjunction with four-hole-random-punch IBM cards. Machine searching of IBM cards is done with a 1,000-card/min. IBM sorter.

Essentially, Kellogg's Uniterms are key words which stand for ideas and information contained in documents. ("Crack-

10:23 A.M. UNITERMS are coded into their four-punch IBM language.



10:25 A.M. SORT-DOWN is begun with about 1,000 cards in IBM sorter.

10:31 A.M. SEARCH is finished and the document numbers are noted.

10:32 A.M. DOCUMENTS are taken from files and sent to engineer.

ing," "cost" and "naphtha" are typical Uniterms.)

Each Uniterm is represented by four holes, randomly punched in columns 41 through 80 of an IBM card. For example, random punches signifying "cost" are (listing first the number of the column, then the digit punched in that column) 61/0, 68/0, 71/1, 77/8.

Pratt himself designates random punches for new Uniterms, as needed, from the Rand Corp.'s list of 1 million random digits. Kellogg's dictionary of Uniterms now lists about 3,000 in all.

Other information is punched into columns 1 through 27 to identify the referenced document as to date, file location, process, product, company concerned and job number. Twelve columns are thus left available for future use.

Right now, Kellogg is processing documents and listing Uniterms pertaining to design, construction and piping. Pratt feels he will be able to get a very fine breakdown of information with a total of about 7-8,000 Uniterms. Eventually, he expects the system will need about 15,000.

▶**Filing and Retrieving**—Here's a simplified rundown on the steps in processing a document for filing and eventual retrieval:

Document is read and an abstract prepared on a 5 × 8-in. index card, listing all information—including Uniterms—that will be punched into the IBM card. The card is prepared and then it, the abstract card and the document are filed separately. Frequently, as many as 20 Uniterms are listed with the abstract and punched into the IBM card.

Retrieving documents pertinent to a search (see photos) is a matter of selecting, say, three or four Uniterms which best define the information desired, and translating them into their four-punch designation. Then with IBM sorter preset (at column and digit of one punch) you make consecutive run-throughs or sort-downs until the cards left give the location of all pertinent documents.*

▶**For Faster Searches**—Kellogg has incorporated some refinements gained from the experience of other firms.

Pratt plans to keep all cards of one broad process category (cracking, for example) in blocks of 5-10,000. So, in general, you need to search only one block. An exception, Pratt notes, might be patent or legal work where all blocks would be searched.

One big help in keeping the system flexible and up to date is listing Uniterms on a document's abstract card. For it's important to be able to change or add Uniterms and to reclassify documents as the need arises. And you can't be sure, from the holes alone, just what Uniterms have been punched.

There may be a time when you want to consolidate cards in two or more categories under one Uniterm. On the other hand, you sometimes want to get a finer breakdown of a single large category. For example, "cracked naphtha" might be conveniently broken down into Kuwait or domestic crude.

▶**Fewer "False Drops"**—With the four-hole random-punch system, there's a statistical probability of a "false drop," a certain percentage of cards in a sort which may have nothing to do with the information you're after (see footnote, below). This probability climbs as you pyramid more and more Uniterms onto a single card.

So, where some users of similar systems pyramid as many as 50 Uniterms on a single IBM card, Kellogg uses additional cards for the document and limits the number of Uniterms to 20 per card.

This cuts the percentage of false drops from about 5% to near 2%.

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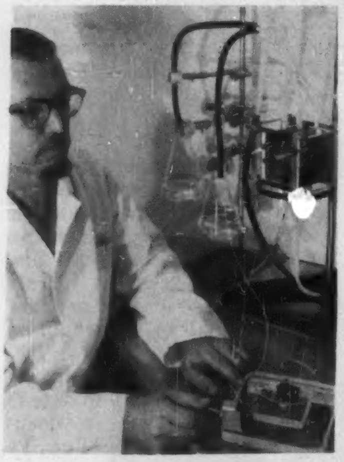
* Because Kellogg's sorter, under the present setup, can "read" only one punch on each sort-down, the usual procedure is to sort out the first punch of one Uniterm, then sort from the resulting cards the first punch of another and so on. Actually, it's possible to get a "false drop" or card which doesn't pertain to your search, because one punch of a Uniterm may be the same as a punch of an entirely different Uniterm.

15 minutes TOTAL TIME is needed from time engineer confers with Pratt until information is searched and desired documents are located.



Fuel Cells May Star in Satellite Power Picture

Latest of the companies to declare itself officially in the race for an economical portable power package is Lockheed's Missile Systems Div. Lockheed is hurrying development of a fuel cell compact enough to supply the electrical power needs of earth satellites and space vehicles. Above, Lockheed scientist Ross Quinn shows laboratory-size fuel cell can power a small electric motor. Quinn is associated with physical chemist M. Eisenberg, project director.

Lure of generating electricity directly from chemical reactions, with better than 80% fuel efficiency, has been attracting many firms into fuel cell research (*Chem. Eng.*, Nov. 3, 1958, p. 49). Space vehicles are just one of the many potential applications of fuel cells; they could find use anywhere a small, lightweight energy source may be required.

Lockheed isn't disclosing the technical details of its cell, says only that fuel can be "any high-energy compound; gas, liquid or solid; e.g., hydrogen, oxygen or chlorine." While Lockheed did not specify which solids, some existing fuel cells can run on lithium hydride—used as a source of hydrogen. These cells could technically be called solid-fueled.

▶ **Power Potential**—Lockheed is scaling its model up to a cell that will deliver 0.1 kwh./lb. ten times the power output per pound of an auto battery. In five years, firm expects to have a cell delivering 0.3 kwh./lb.

One fuel cell expert, commenting on these figures, points out that the weight figure must include the weight of the fuel in order to be meaningful. National Carbon, which jumped into the fuel cell picture a year ago (*Chem. Eng.*, Dec. 1957, p. 154), says that its carbon-electrode cell could also be scaled up to deliver 0.3 kwh./lb. including fuel.

General Electric, also interested in generating electricity in space, is known to be researching fuel cells and thermionic converters—a device for converting heat energy directly to electricity.

New Technique Produces High Vacuum at Low Cost

A new technique for achieving ultra-high vacuums was revealed recently at a meeting of the American Vacuum Society in San Francisco, Calif. Bruce M. Bailey, of Arthur D. Little, Inc., described a system, cryopumping, which can produce extremely low pressures—about one-millionth of an atmosphere—economically enough for large-scale industrial applications.

Essentially an ultra-low- temperature refrigerator using helium as a refrigerant, the first large-scale cryopumping installation is now operating in a hypersonic wind tunnel at the University of Southern California. Bailey believes that cryopumping has industrial potential in any application where diffusion pumps are now used.

Moreover, costs are attractive, Bailey asserts. He cites USC's wind-tunnel installation, where cryopump is powered by a 50-hp. motor. A comparable system using gaseous diffusion pumps would require 500,000 hp.

▶ **An Old Concept**—Although the cryopump is based on an old principle, practical applications are quite new.

Cryopump consists of a refrigeration unit which circulates gaseous helium at –420 F. through coils in plate condensers. Unit reduces temperature in a system to a point where air or other gases condense, leaving a vacuum. Below the triple point of gases in the system, lowering the temperature results in a sharp reduction of pressure to produce a high vacuum.

Theoretical limit of cryopumping alone is about 0.1 mm. of mercury, which is the sum of partial pressures of noncondensables (hydrogen, helium, neon) in the atmosphere. However, mechanically pumping down to 1 mm., followed by cryopumping, can achieve vacuums of about 10^{-4} mm. Removing noncondensables by flushing the system with nitrogen or Freon should allow vacuums up to 10^{-8} or more.

Bailey explains that cryopumping is now used most efficiently in conjunction with a mechanical pump. This is because pumping rate of a mechanical system falls rapidly as vacuum increases, while cryopumping rate increases.

USC's cryopump freezes out nitrogen at one end of the wind tunnel, causing a flow of nitrogen from the other end over objects being tested. Pure nitrogen is used because triple point (about –345 F.) is high enough for rapid condensation using helium refrigerant. Cryopump's expansion engine consists of two parallel-operation stainless-steel cylinders and pistons, 1¾-in. bore with a 2-in. stroke.

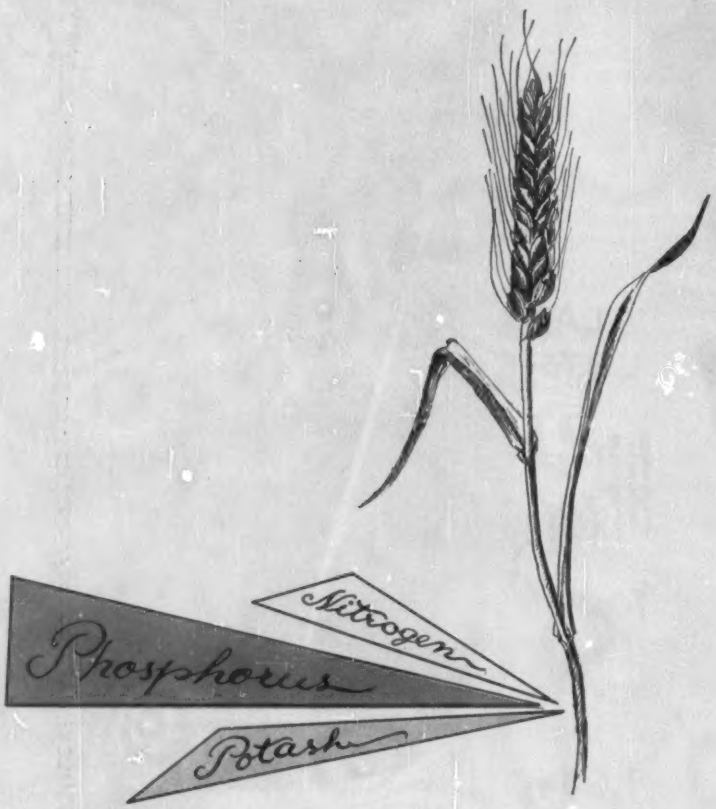
NEWS BRIEFS

Dry adsorption: Canadian Export Gas & Oil, Ltd., has installed a dry desiccant processing plant at Steveville, Alberta, to remove hydrocarbons from gas delivered to Trans-Canada Pipe Lines, Ltd., and bound for export. Plant, using silica gel, removes about 66 bbl./day of saleable condensate from 22,000 Mcf./day of gas.

Polyethylene: Dow Chemical Co. has now doubled its original polyethylene capacity at Freeport, Tex., and is building a linear polyethylene plant at Bay City, Mich.

DEVELOPMENTS . . .

CHEMICAL ECONOMICS EDITED BY D. R. CANNON



10-10-10
6-18-6
10-30-0
10-30-10
0-54-0

Phosphorus grabs the plant-nutrient spotlight as use of "super" phosphoric acid yields the richest fertilizers ever.

P_2O_5 Is Making the News in Fertilizers

Take a look ahead at fertilizers through the eyes of the Tennessee Valley Authority and you'll see that most of the action centers around phosphorus. On its combination in higher-analysis fertilizers, its recovery from electric furnace sludges and liquors and from low-grade ores.

Eventual benefits from all this "phosphorus" work could range from reduced shipping and distribution costs for fertilizers, added convenience for the farmer, and huge, hitherto-untapped supplies of phosphorus, fluorine and uranium.

Here are the highlights of TVA's development program for the current fiscal year:

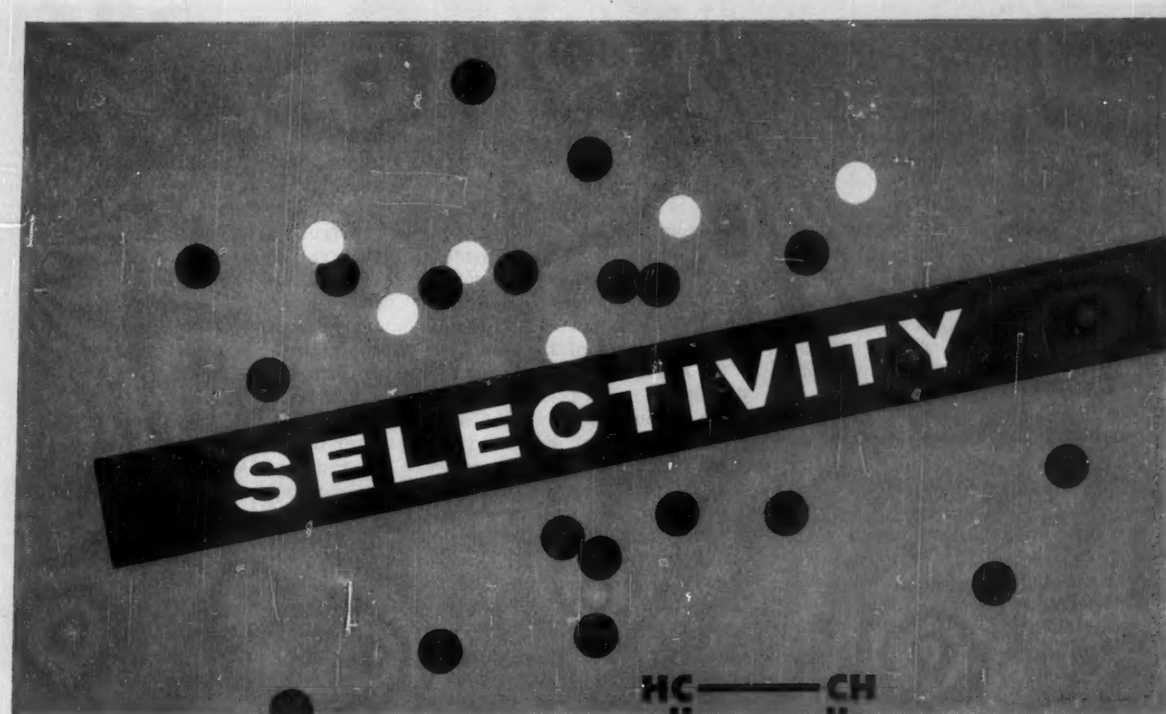
- Liquid phosphorus-nitrogen fertilizers with 50% total plant nutrient—richer than anything on the market today.
- Concentrated superphosphate with the highest analysis —54% available P_2O_5—commercially attained.
- Better phosphorus recovery from sludges and liquors in electric furnace processing.
- High-analysis phosphorus fertilizers from low-grade phosphate rock.
- Fluorine recovery in phosphate fertilizer production.

▶ **"Super" Acid**—TVA's recent ventures in developing a superphosphoric acid—75-78% available P_2O_5—is beginning to bear fruit. (Top-grade phosphoric acid used in commercial nitrogen-phosphorus fertilizers today analyzes only 54%.)

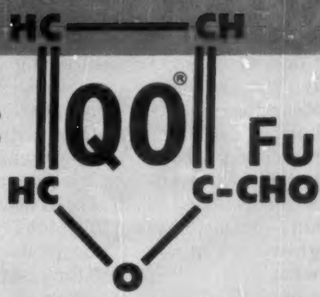
During the past year four fertilizer manufacturers used about 480 tons of TVA's superphosphoric acid in exploratory processes. Additional firms are now requesting the acid.

Results, so far, include production on a demonstration scale of liquid fertilizers containing nearly 50% total plant food (nitrogen, phosphorus and potash). Compare this analysis to the 32% or less plant food content attained with the highest-strength phosphoric acid in commercial use today.

Plans this year also call for using the new acid to produce a superphosphate of exceptionally high analysis—54% P_2O_5 vs. 45-48% for conventional concentrated superphosphate.



always a feature of



Furfural

Both structure and physical properties of furfural support its wide use as a selective solvent. This highly polar molecule favors sharp separations of saturates from unsaturates in lube oils, gas oils, cycle stocks, and other petroleum products. It is even effective in separation of organic sulfur compounds, or heavy metal complexes from petroleum fractions. The excellent selectivity is proven daily by the high yields of finished products from commercial installations throughout the world.

Add to this feature the fact that furfural is readily recovered from aqueous or non-aqueous solutions by flash vaporization, straight distillation, steam stripping, or water extraction at surprisingly low cost. The net result—use of furfural is paying off for many people, and it can do as much for you.

Solvent refining with versatile QO furfural is a process worth investigating. May we discuss the matter with you? Write The Quaker Oats Company, Chemicals Department.

The Quaker Oats Company
CHEMICALS QO DEPARTMENT

The Quaker Oats Company
CHEMICALS DEPARTMENT

Write for Bulletin 203-A, "Physical Data on QO Furfural"

335N, The Merchandise Mart, **Chicago 54, Illinois.** Room 535N, 120 Wall Street, **New York 5, New York.** Room 435N, 48 S.E. Hawthorne Blvd., **Portland 14, Oregon. In the United Kingdom:** Imperial Chemical Industries, Ltd., Billingham, England. **In Europe:** Quaker Oats-Graanproducten N. V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota," Copenhagen, S. Denmark. **In Australia:** Swift & Company, Ltd., Sydney. **In Japan:** F. Kanematsu & Company, Ltd., Tokyo.

▶ **P_2O_5 in Liquids**—TVA's superphosphoric acid will speed the trend to use of phosphorus in liquid fertilizers. Cost of P_2O_5 in acid still is higher than in most solid materials. But mixing acid with low cost liquid nitrogens lowers the total cost of applying plant nutrient to the soil. Availability of the new phosphoric acid will help fertilizer mixers come up with liquids which don't salt out, gel, or form precipitates that clog spreading equipment.

In fact, one liquid fertilizer firm found it possible to make stable, highly concentrated liquid fertilizers with wet-process phosphoric acid. The secret ingredient: some superphosphoric acid to sequester the impurities in the wet-process acid.

▶ **Makeup on the Spot** — The same firm also used the superphosphoric acid to prepare strong base solutions which could be moved to outlying tank farms for addition of other ingredients and final distribution.

"This couldn't be done," TVA engineers noted, "with conventional acid of lower concentration. You couldn't make base goods with a high-enough analysis to start off with."

Another company found that the best selling mixed fertilizer in its area (14-7-7) can be made with superphosphoric acid and urea-ammonium nitrate solution. With conventional furnace acid, solid urea must be added to provide 90% of the nitrogen. This makes for a costlier product.

The remaining two fertilizer firms made experimental runs with the new super acid to produce liquid fertilizers of higher analysis or better physical properties than could be made with the usual furnace acid. Some of the grades made and sold: 10-30-0, 10-10-10, 6-18-6.

▶ **Fluorine Bonus**—Even TVA's fluorine-recovery project concerns phosphorus. For it's the few percent of fluorine in domestic phosphate rock that TVA is after. The agency hopes to devise a process for economical recovery of byproduct fluorine compounds—now wasted in phosphate operations—in a form suitable for use in the chemical, plastics, steel and aluminum industries.

TVA figures that domestic phosphate rock is abundant enough to supply—given the technology—40% of our domestic fluorine needs, needs which run around 250,000 tons/yr. This would obviously be an important supplement to the free world's dwindling reserves of high-grade mineral fluorspar, now virtually the sole source of fluorine.

TVA hopes to achieve major economies in its fertilizer operations through recovery of other waste products. For instance, Muscle Shoals engineers are trying to boost recovery rate of elemental phosphorus from sludges and liquors in the furnace-phosphorus plant. And at TVA's ammonium nitrate plant, work is moving ahead on processes for recovering hydrogen and nitrogen from waste gases.

▶ **Skimming the Top**—Leached-zone phosphate rock, a material occurring in very large tonnages as a covering for higher-grade phosphate ores in Florida, is another target for recovery work. At present the leached-zone material is stripped away and discarded—a waste of some 14 million tons/yr. of this aluminum phosphate ore.

Successful tapping of the enormous reserves of this now-discarded material would make mining of conventional rock more economical and would conserve the shrinking supply of phosphates in the Southeast, a region which traditionally consumes most of this fertilizer.

Looking toward the day when higher-grade rock reserves become less economical to mine, TVA figures the leached-rock material will become commercially attractive. An added bonus is the uranium contained in leached-rock phosphate—a potential reserve (albeit well in the future) against the day when cheaper uranium sources run out.

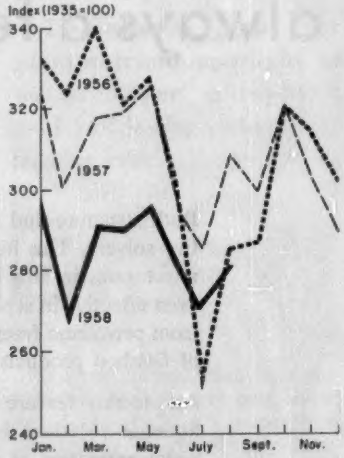
▶ **Go West**—On the other hand, some developments in the phosphorus field may, by lowering freight costs of plant nutrients from manufacturing plants to farms, accelerate production of phosphate fertilizers from western fields.

One such development is the already-discussed superphosphoric acid. The second is the wide scale introduction to farmers, under TVA's educational programs, of calcium metaphosphate, which contains 62-64% available P_2O_5.

Central Farmers' Co-op is constructing a plant to manufacture this product, along with conventional phosphate fertilizers, from electric-furnace phosphorus. (Usual practice is to manufacture phosphate fertilizers by acidulation of phosphate rock.)

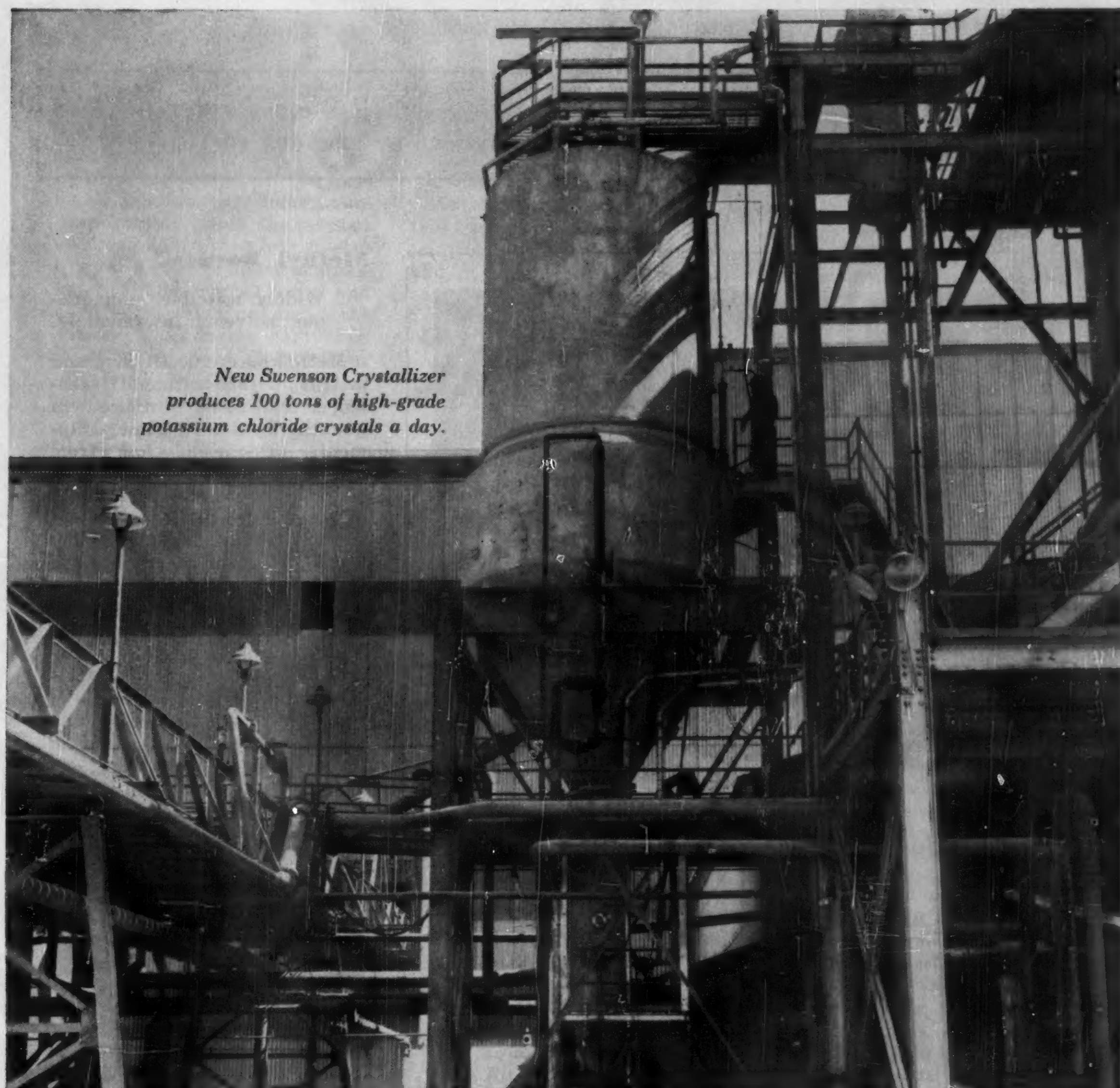
Another new phosphate fertilizer to watch is magnesium ammonium phosphate, made on a pilot-plant basis from olivine (a magnesium-iron silicate) and phosphate rock. This could become an important commercial product—there's a rising need for magnesium nutrient in many farm areas—if pilot-plant and economic evaluations come up with favorable appraisals.

Chemical Consumption



Consumption by Industries

	July (Final)	Aug. (Est.)
Coal products	7.2	7.5
Explosives	8.8	10.5
Fertilizer	53.4	49.6
Glass	27.9	29.2
Iron & steel	11.8	13.4
Leather	4.1	4.1
Paint & varnish	35.0	36.3
Petroleum refining	30.5	31.5
Plastics	19.7	23.5
Pulp & paper	33.0	37.3
Rayon	23.2	23.7
Rubber	5.5	5.2
Textiles	7.7	9.0
Total	**268**	**281**



New Swenson Crystallizer produces 100 tons of high-grade potassium chloride crystals a day.

Forward Step in KCl Crystallization

A new Swenson Crystallizer is helping the National Potash Company of New Mexico make KCl (potassium chloride) crystals of the desired size and of exceptional uniformity. The operation is simple and stable. Downtime is minimized due to an unusually long boil-out cycle.

Swenson Crystallizers are designed to meet your requirements, both as to construction materials and capacity. New technical paper gives valuable facts. Send for it today. *Swenson Evaporator Company, 15669 Lathrop Avenue, Harvey, Illinois.*

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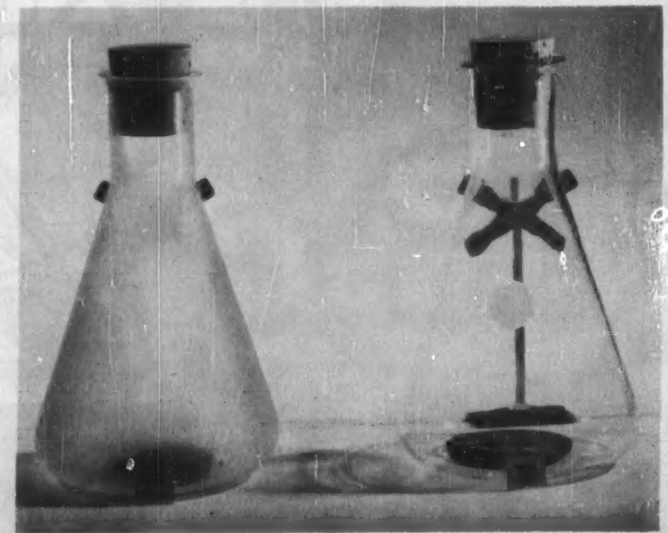
DEVELOPMENTS . . .

CHEMICAL PRODUCTS EDITED BY FRANCES ARNE



No Heat Clouds From Plasticizer-Guarded Vinyl Chip

Vinyl auto interiors will no longer cause windshield fog on hot days if vinyl is compounded with new plasticizer. Flask at right contains vinyl made with new product while flask at left holds vinyl compounded from conventional plasticizer. Cloudiness in the latter resulted after both were heated intensely.

Called Elastex 37-R, plasticizer is a high molecular weight material specifically designed for vinyl compounding.

A medium molecular weight material, Elastex 36-R, has been developed for more general use. —Allied Chemical Corp., Plastics & Coal Chemicals Div., New York, N. Y. 36A

Phenolic Resin

Gives nitrile adhesives improved tensile strength.

A new heat-reactive phenolic resin makes possible the production of nitrile rubber adhesives with excellent green tack, high tensile strength and high thermal softening point.

Designated SP-12, the new resin is an oil soluble, crushed phenolic, characterized by extremely fast cure. It is completely compatible with nitrile rubber and soluble in aromatic or aliphatic solvents.

Laboratory and field tests have demonstrated that a significant improvement in the tensile strength of an adhesive can be made by milling SP-12 resin with the nitrile rubber before cutting with a solvent. It is usually used in quantities up to 100 parts of resin per 100 parts rubber.

Uses include pressure sensitive, cold setting and heat setting nitrile adhesives for a variety of industrial applications. Good bonds with most porous materials and fair bonds to metal are possible. — Schenectady Varnish Co., Schenectady, N. Y. 36B

Methyl Borate

Widely miscible, nonaqueous solvent, intermediate.

Methyl borate, $B(OCH_3)_3$, and methyl borate-methanol azeotrope, are being produced in quantities that permit shipments in carload lots from Lawrence, Kan.

Methyl borate serves as a catalyst for condensation of ketenes with aldehydes or ketones to form β-lactones. It forms azeotropes with many other liquids and has been used to separate various types of hydrocarbons, especially close-boiling naphthenes, by azeotropic distillation.

It is a neutron absorber and detector. Since combustion of methyl borate forms boric oxide, its addition to plastics, lacquers, enamels and similar materials may reduce flammability of films.—**Callery Chemical Co., Pittsburgh, Pa. 36C**

Epoxy Resins

They open low-cost way to vacuum-forming molds.

Molds, fabricated with epoxy resins by a newly-developed spray technique, are designed primarily for short-run prototype applications, and give service equal to that of metal molds made by toolmaking techniques.

Construction of the mold be-

gins with application of a release agent on the pattern for the mold. This is followed by coating of the pattern with a gel coat which provides the surface characteristics of the final mold. In the case of small vacuum-forming molds, the gel coat contains flaked stainless steel—to a ratio of 20 to 30 parts stainless to 100 parts resin and hardener—which enhances the surface reproducing characteristics of the epoxy. A first layer of aluminum fiber is applied while the gel coat is still wet.

After the gel coat is allowed to reach a slightly tacky state—a matter of about 20 to 30 min.—a first ⅛-in. build-up layer of resin and fiber is applied and compacted, then the second layer is applied and compacted.

When the formulation has hardened, the mold is removed from the pattern, ready for trimming and installation into the vacuum forming equipment.

Development of the construction technique results from joint research of Union Carbide and A. Gusmer, Inc., developer of the spray equipment.—**Union Carbide Plastics Co., New York, N. Y.** 36D

Molybdenum

Mb seed treatment can up legume crop 50%.

A new form of the essential element molybdenum can be applied when inoculating seed. Playing vital roles in nitrogen fixation and utilization, it makes possible increases in crop yield up to 50%.

Called Moly-Gro, it is a combination of three basic ingredients—a special form of molybdenum, the adhesive compound and a sequestering agent. The new material sticks to the seed, providing a uniform coating which won't rub or wipe off during planting or handling. Other forms of molybdenum do not adhere adequately unless mixed with some sort of sticker, a messy and time-consuming step.—**Climax Molybdenum Co., New York, N. Y.** 37A

Quartz Cloth Makes Plastic Stand Up to 5,000 F.

In flame tests, equal-thickness panels of steel, glass-reinforced plastic, and quartz-reinforced plastic were submitted to an oxy-hydrogen torch for 40 seconds. Flame temperature of more than 5,000 F. melted and burned through both steel and glass-reinforced plastic in less than this time. Quartz-reinforced plastic withstood the flame and retained its structural strength.

Pure quartz is in a newly-developed form: .005-in. dia., continuous monofilaments of fiber. Twisted into thread and woven into cloth on textile equipment, it bids for wide use as a plastic reinforment in aircraft and missiles on the basis of greatly improved strength-to-weight ratios. However, the properties of quartz that make it of value as a product, cause difficulties in manufacture that result in a price many times that of ordinary fiber.—General Electric Co., Nela Park, Cleveland, Ohio. 37B

Already available are materials combining the fibers with Haveg resins. Temperatures they'll resist are expected to be far in excess of those limits set by resin-asbestos and resin-glass combinations now being used for exit cones, blast tubes, motor case liners on existing missiles. —Haveg Industries, Wilmington, Del. 37C

BRIEFS

First vinyl wrinkle finish for metals has been developed by incorporating a compound known as Monomer MG-1 into vinyl plastisol, organosol, or solution coating formulations. Difference between rate of polymerization of MG-1 (polyethylene glycol dimethacrylate) and the rate of vinyl resin fusion is believed to cause uniform wrinkling.—**Union Carbide Chemicals Co., New York, N. Y.** 37D

Hydrochlorothiazide shows promise in current clinical tests of being a more potent derivative of chlorothiazide, company's highly successful diuretic, called Diuril. Called HydroDiuril, the new product—like the old—is effective orally.—**Merck & Co., Rahway, N. J.** 37E

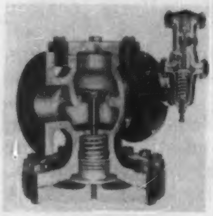
Nickel bromate, manganese fluoborate, lead hydroxide (basic) and cobalt (ous-ic) oxide are now available to research chemists for the first time.—**City Chemical Corp., New York, N. Y.** 37F

For More Information . . . about any item in this department, circle its code number on the **Reader Service** postcard (p. 105)

DEVELOPMENTS . . .

PROCESS EQUIPMENT EDITED BY C. C. VAN SOYE

Latest Developments

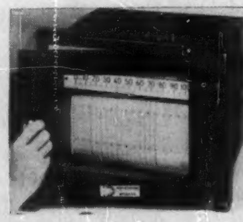


Regulator

For accurate, fast-response control of steam flow. *102A*

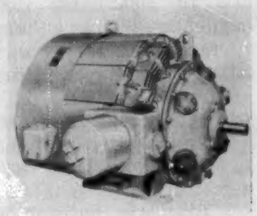
Xerography

Makes news with introduction of automatic printer. *100A*



Multipoint Recorder

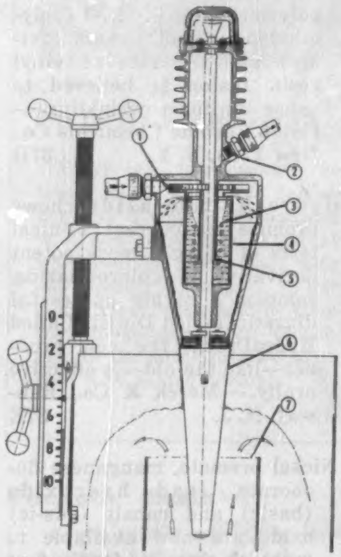
Adapts to a wide variety of recording jobs in just three minutes. *101A*



D.C. Motor

Extends range of adjustable speed from 5% to 400% base value. *40D*

Page number is also Reader Service Code Number



Consistency Control

Fluid drag forces convert to air resistance.

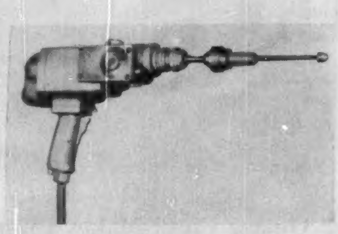
Although designed primarily for measuring consistencies of stock suspensions in paper mills, the Kolle control system may find other applications throughout all of the process industries. According to the manufacturer, the system will measure and control consistencies between 0.5 and 6% with great accuracy. Heart of the system is a cleverly designed indicator, schematically shown at the left. Having only one moving part, the indicator is claimed to be rugged and maintenance-free.

In paper production, the indicator's output activates a controller, which automatically adjusts dilution rates to conform with preset consistency. A recorder keeps accurate records of both dilution volume and consistency.

Here's how the indicator works: A nozzle-ejected stream of water spins a shaft-mounted turbine (1). Water leaving the turbine blades maintains the level within a rotating vessel (4) attached to the same shaft as the turbine. Vessel rotation creates a vortex (3), the depth of which is proportional to speed of spin.

The sensing element (6), which is also attached to the turbine shaft, tends to slow the speed of vessel rotation in proportion to frictional drag exerted by the stock suspension (7).

An air stream introduced at (2) measures, through the bubble-pipe principle, the distance between (5) and the bottom of the vortex. This distance, indicated at the controller as a resistance to air flow, gives an accurate measure of the stock's consistency.—**Rosenblad Corp., New York, N. Y.** 38A



Expander Drives

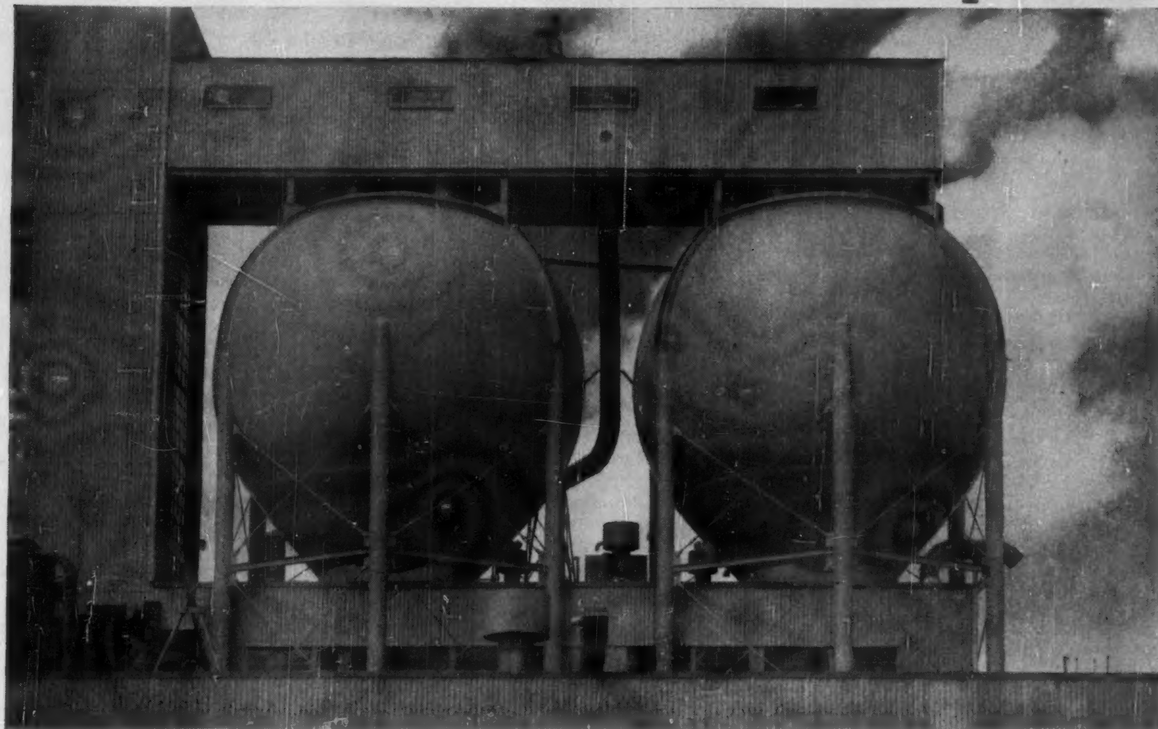
Round out line of tube-rolling equipment.

Two new air-driven, heavy-duty, automatic tube expander drives have broadened the manufacturer's line of Torque-Air-Matic equipment. Both models utilize a mechanical device to measure torque output directly at the mandrel.

Model B, which is designed for use on ferrous or nonferrous exchanger tubes up to 1½ in. O.D., comes in three versions. These range from 38 to 22 ft. lb. torque at 450 to 750 rpm.

Available with 75 ft. lb. of torque at 200 rpm., Model C will roll up to 3 in. in ⅝-in. sheet. It will probably find

The Case of the Airborne Conispheres:



Why Linde wanted them . . . How CB&I designed and built them

In order to keep a ready and free-flowing supply of calcium carbide available for generation into acetylene, the Linde Company specified that these two 500-ton capacity Conispheres* be installed on the roof of their Montague, Michigan, plant. In order to overcome a specific set of problems it was necessary for CB&I to incorporate special features into their design and construction. Here's how it was done:

Problem: *Insure safe, continuous operation.*

Solution: (1) Structures were designed to meet a specified emergency condition at an increased stress level, as well as to meet normal service conditions at normal stress levels in all parts not governed by explosion conditions. (2) A series of six safety outlets vent tanks upward. (3) Heavy baffle plates were suspended inside the tanks to control flow of carbide.

Problem: *Tanks must support superimposed load of gallery and feed belt equipment.*

Solution: Special framing distributes load to supporting columns of the tanks.

Problem: *Tanks must be mounted on sloping roof.*

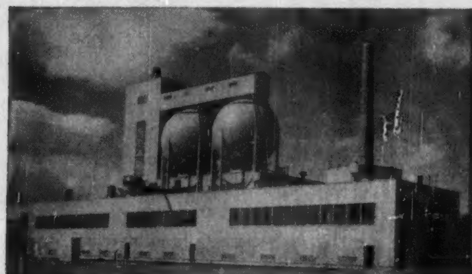
Solution: Three of the supporting columns are longer than others to compensate for roof plane.

Fully coordinated facilities for the design, fabrication and erection of standard or special steel plate structures permits CB&I to work to the most exacting requirements. . . . For this reason industry leaders call on CB&I for the tough jobs and rely on the quality of workmanship that goes into *any* CB&I built structure. A new booklet describes CB&I FIELD SERVICES . . . write our nearest office.

At Montague, Michigan, Linde is one of three major companies combining their talents and mass production facilities to produce DuPont Neoprene. Linde Company is a division of Union Carbide Corporation.

*A Conisphere is a Hortonsphere® designed with conical bottom outlet.

E55C



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greatest application in package or power plant boilers.—**Thomas C. Wilson, Inc., Long Island City, N. Y.** **38B**

Stream Analyzer

Measures boron content in process liquids.

Designed primarily as a process monitor for the manufacture of boron-based fuels, the new MSA boron analyzer is claimed to be accurate to ±1% by volume. Measurement of the total boron content of process streams in borax production is another natural field of application for the new device.

In operation, the instrument actually detects the B-10 isotope. As the process stream flows between a thermal-neutron emitter and a counter tube, the boron atoms capture colliding neutrons. Thus, with rise of boron concentration, neutron incidence at the detector falls off.

This results in a decrease of pulse generation rate feeding through a scaler to the pneumatic recording system. Strip-chart records read directly in terms of boron concentration.—**Mine Safety Appliances Co., Pittsburgh, Pa.** **40A**

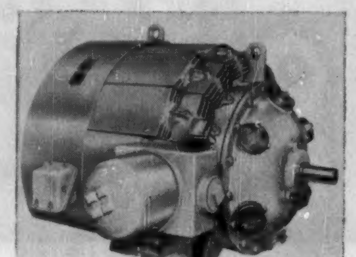
Compressor Controller

Eliminates routine inspection. Lowers maintenance.

After the start button is pressed, the new Tendamatic automatic compressor control system takes over the job of continuously supervising compressor operation. The system checks air and oil pressures and temperatures, and lubricator operation. It monitors the float level in condensate traps and watches for leaking valves as well as mechanical failure of running parts.

If abnormal compressor operation occurs, the system gives both audible and visible warnings, and indicates the trouble. If plant personnel take no corrective action, the compressor shuts down.

Tendamatic is available only for the manufacturer's 100- to 7,500-hp. machines.—**Ingersoll-Rand Co., N. Y., N. Y.** **40B**



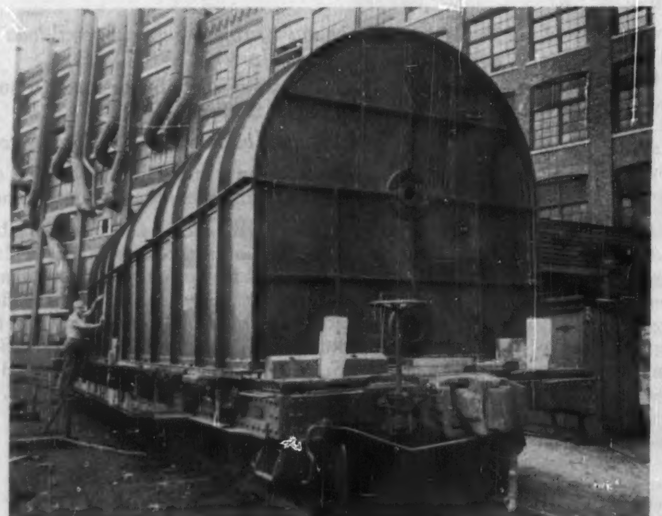
D. C. Motor

Has efficient air-to-air cooling system.

Range of adjustable speed offered by a new d.c. motor extends from 5% of base motor speed (constant torque) to 400% of base speed (constant horsepower). To enable such a broad speed range, an integrally mounted a.c. fan supplies a constant flow of cooling air.

For effective air-to-air heat removal, heat exchanger tubes of heavy-section aluminum alloy surround the periphery of the field ring. Air flow through the tubes is independent of motor speed.

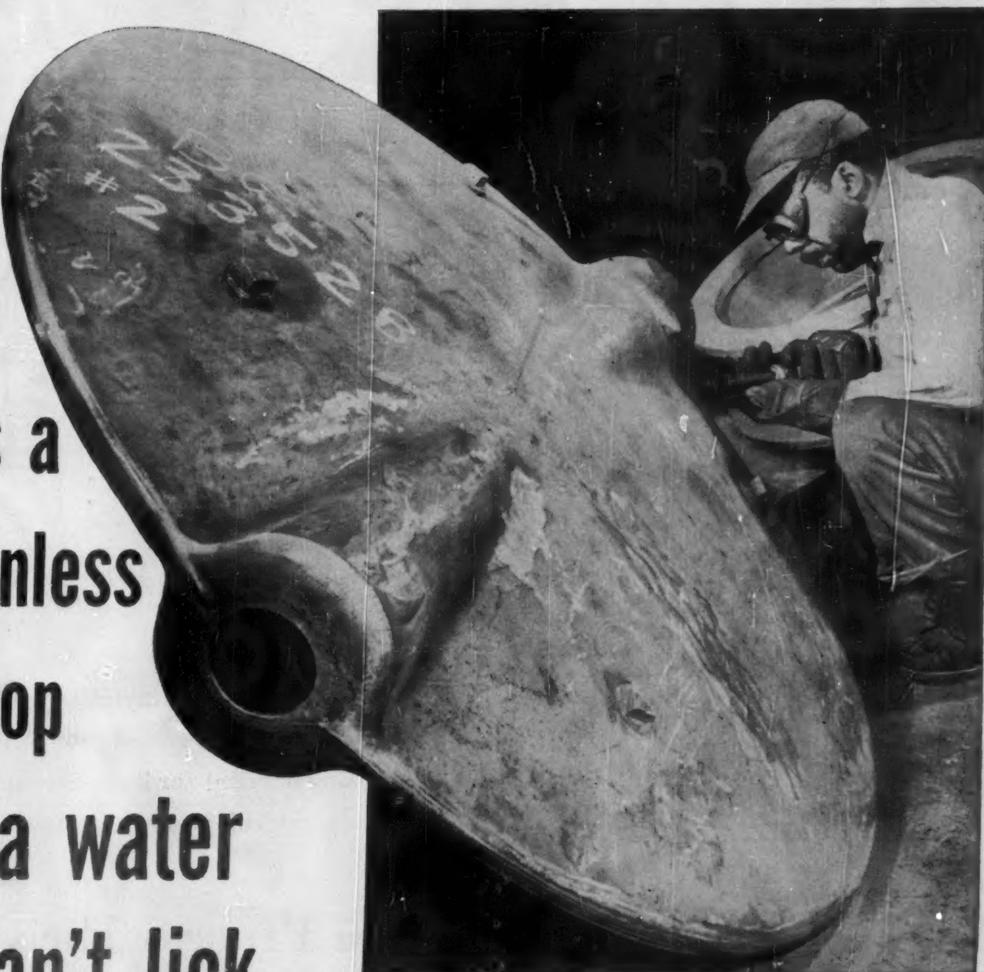
Available in ratings from 25 to 300 hp., the motors also feature an explosion-proof enclosure for hazardous areas (Class I, Group D). Special construction also protects working parts from abrasive airborne particles and other severe atmospheric conditions in indoor or outdoor service.—**Louis Allis Co., Milwaukee, Wis.** **40D**



Rubber-Lined Tank to Keep Cleansing Agents Clean

More than 1,000 lb. of crude rubber went into the $\frac{5}{16}$-in. protective lining on these steel tank sections. When assembled at the Sinclair Mfg. Co.'s Toledo, Ohio plant, the sections will form a huge elliptical blending tank (18 x 9 x 16 ft.) for compounding liquid detergent ingredients. The rubber lining will prevent metallic contamination of product solution.—B. F. Goodrich Industrial Products Co., Akron, Ohio. 40C

Automatic Xerography and other equipment news on page 100.



Here's a stainless lollipop sea water can't lick

This large (48″ dia., 1701 lbs.) and unusual stainless casting was fabricated by Allegheny Ludlum's Buffalo, N.Y. foundry. It is scheduled for service under the most severe operating conditions, functioning as a wafer valve disc at 25 psi pressure in sea water. Since long life and tight closing are essential in this application, corrosion resistant Type 304 Allegheny Stainless was specified.

Some unusual techniques were employed in the fabrication of this casting. Although the entire valve disc was cast as a single piece, its sides are hollow, with a skin only ¾″ thick. The center shaft was cast solid at the same time the side wings were cored, permitting the single piece, seamless part desired.

If you have a casting problem, or *any* problem that involves corrosion resistance, long life, resistance to wear and abrasion, call the Allegheny Ludlum Sales Office nearest you. An A-L Sales Engineer is ready to put his skills and those of the A-L Technical Staff promptly at your disposal, to serve your requirements from the largest and most complete line of stainless products on the market.

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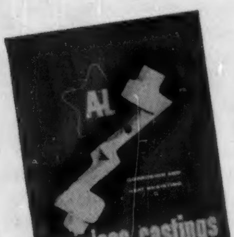

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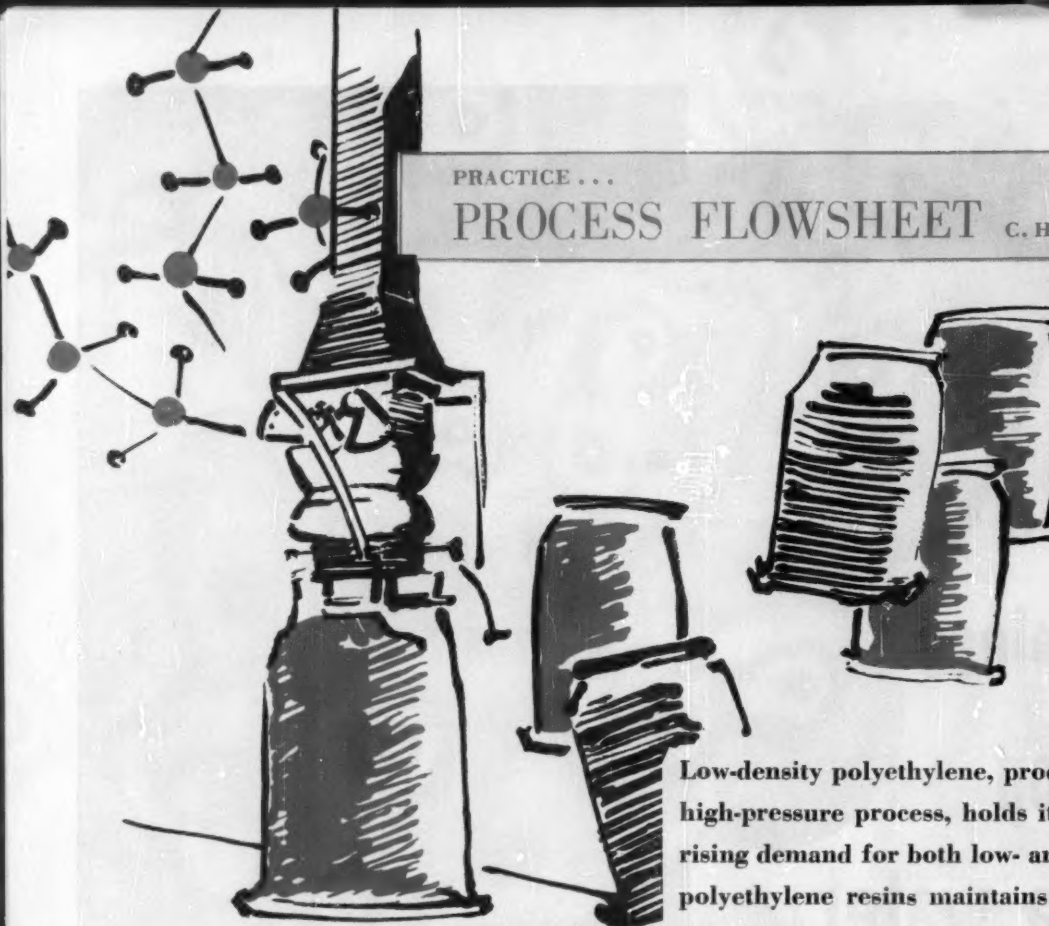


Low-density polyethylene, produced by older high-pressure process, holds its own as ever-rising demand for both low- and high-density polyethylene resins maintains even balance.

High-Pressure Polyethylene Process Thrives

In this age, polyethylene film wraps our food, polyethylene bottles feed our babies and dispense our toothpaste. Polyethylene particles condition garden soil and polyethylene hoses carry water to our lawns. In our process plants, polyethylene gaskets seal piping joints and polyethylene packings fill towers.

To meet these ever-increasing demands, low- and medium-density polyethylene producers continue to up capacity aiming at expansion of the already giant 650-million-lb./yr. market. One of these, Spencer Chemical Co., doubled plant capacity this year at Orange, Tex., can now turn out 90 million lb./yr.

Similar growth characterizes market for linear, high-density polyethylene, produced by newer, low-pressure processes. Present market approaches 150-million-lb./yr. mark.

▶**Linear's Shortcomings** — These Phillips, Ziegler, Du Pont and Standard Oil of Indiana linear-polyethylene processes use metal-based catalysts to polymerize ethylene in a single pass. Resulting polymer is difficult, sometimes impossible, to separate from often costly catalyst. Too, capital and operating costs are high because plant is larger than high-pressure plant with same output.

But high-pressure process, developed and licensed by Imperial Chemical Industries Ltd. (ICI) and used by Spencer, has disadvantages, too. Costly design is associated with high, 20,000-psi. operating pressure. And using oxygen catalyst, ethylene must pass through a series of polymerization stages. On the other hand, oxygen catalyst presents no formidable polymer-purity problems.

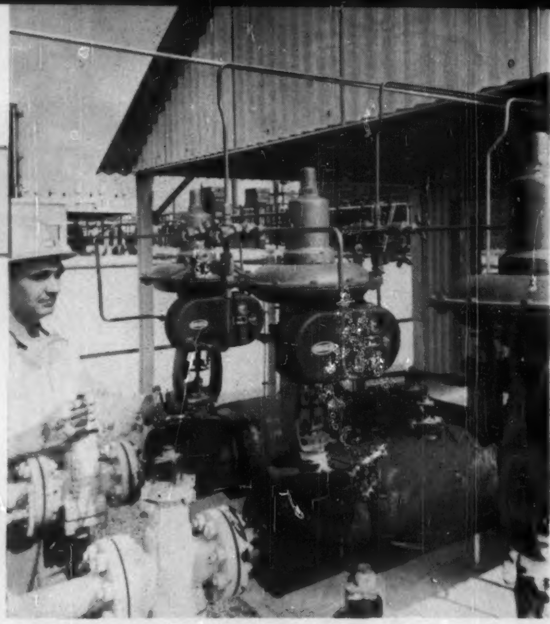
For Spencer's high-pressure process nearby ethylene suppliers, Gulf Oil, Port Arthur, Tex., and Petroleum Chemicals, Lake Charles, La., pipe in raw, 400-psi. ethylene. Before it can be polymerized, chain-terminating agents and other impurities must be removed.

Purification takes two low-temperature distillation steps, one for low-boiling and the other for high-boiling impurities. Raw ethylene (97% pure) feeds to a 70-ft.-high demethanizer column where methane and hydrogen discharge overhead.

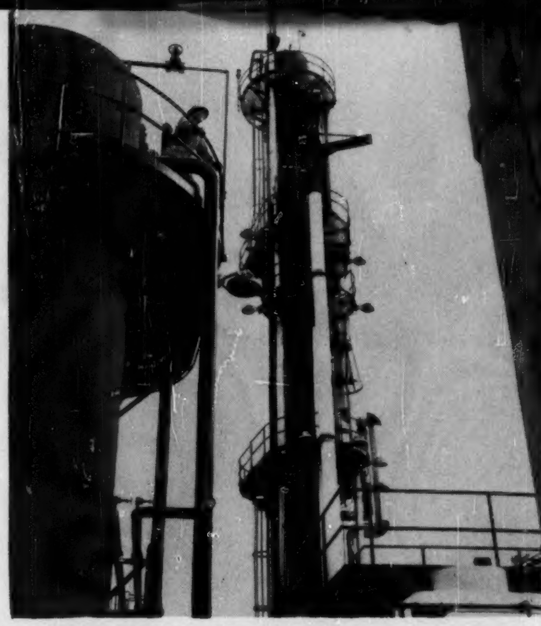
Partly purified ethylene bottoms from the demethanizer first pass through a heat exchanger to cool demethanizer feed, then feed the 120-ft.-high de-ethanizer column. Here, purified ethylene (99% plus) discharges overhead while ethane and other high-boiling impurities discharge as column bottoms.

Reflux compressor pressurizes

Unfold Flowsheet



METERING RAW ETHYLENE: Piped from nearby producers, raw ethylene feeds Spencer's high-pressure process.



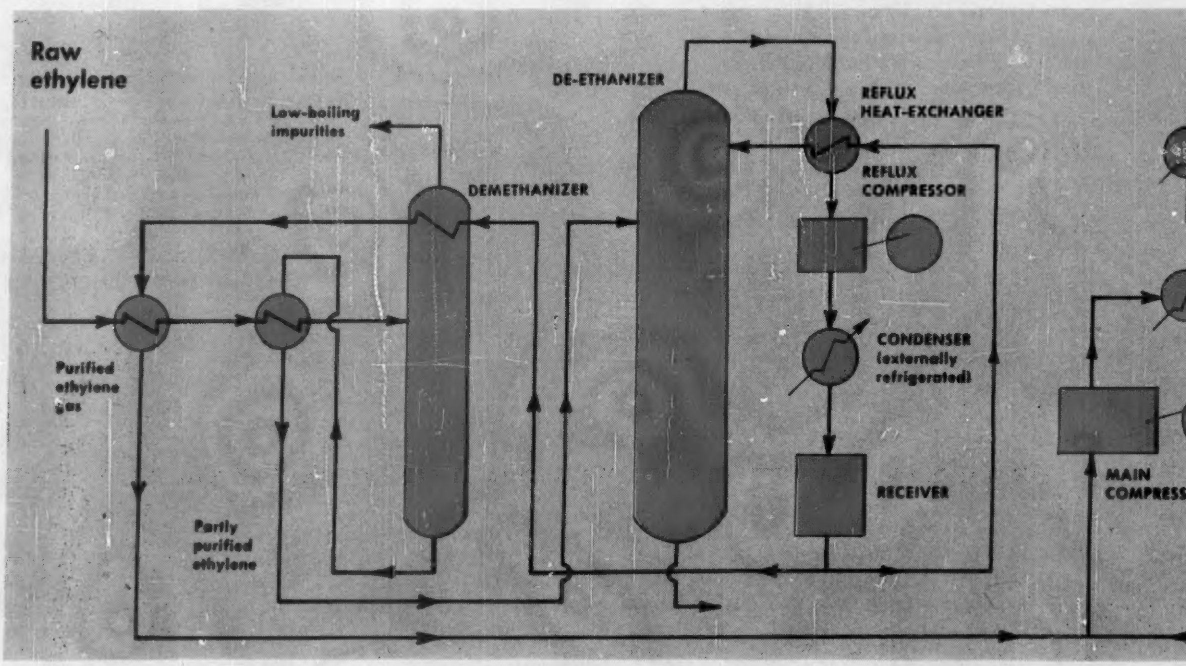
PURIFYING RAW ETHYLENE: Demethanizer and deethanizer distillation towers remove the impurities.

purified ethylene gas. Externally refrigerated condenser liquefies pressurized gas. Resulting liquid ethylene, piped through a heat exchanger in top section of demethanizer, chills escaping low-boiling impurities, thus minimizes ethylene losses. Purified ethylene then passes through another heat exchanger where it vaporizes and precools counterflowing raw ethylene feed.

▶ **The Big Squeeze** — Spencer's huge main compressor boosts ethylene pressure to 20,000 psi., uses 60,000 lbs. of 400-psi. steam hr. in doing so. Heat exchanger adjusts ethylene temperature to 375-410 F. as final preparation for polymerization.

Purified and pressurized ethylene gas feeds a bank of autoclaves where polymerization takes place. Reaction is initiated by a small amount of oxygen (less than 0.1%). Polymerization proceeds in several stages so that high reaction heat may be dissipated readily. When plant operates at capacity, more than 1.8 million Btu./hr. will be generated by polymerization. Autoclaves are specially designed to handle heat and at the same time withstand 20,000-psi. operating pressure.

▶ **Touchy Situation**—Because poly-



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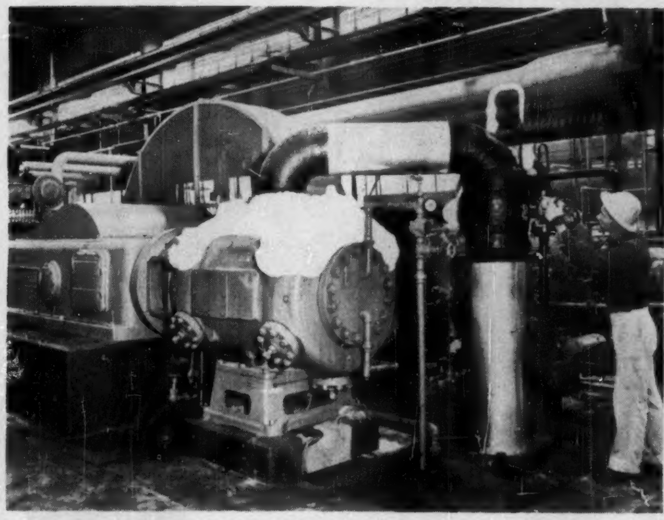
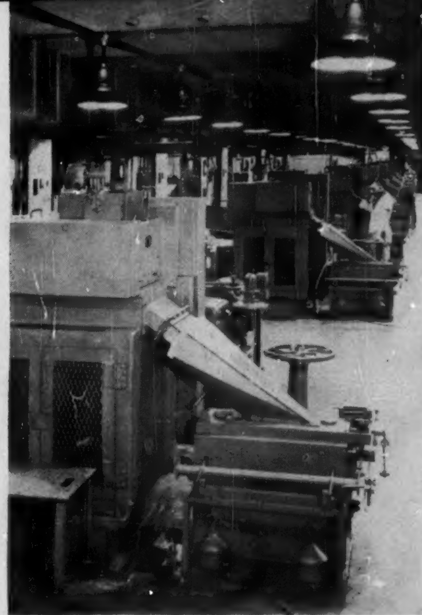


COMPRESSING REFLUX-ETHYLENE: Compressor recycles ethylene through heat exchanger to main compressor, then to autoclaves.



CUBE CUTTING: Choppers slice ⅛-in. cubes from the extruded and solidified poly-rod.

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merization is ultra-sensitive, elaborate instrumentation regulates catalyst concentration, temperature and pressure. Too-high catalyst concentration or too-low reaction pressure results in an average molecular weight below the correct range (8-15,000). Too-high operating temperature results in reversed reaction and the danger of explosion.

Autoclave product, polymer-monomer mixture, feeds separators where at reduced pressures polyethylene condenses and unreacted ethylene remains gas. Separation proceeds by successively reduced pressure stages to a final stage below atmospheric pressure. Ethylene recycles to main compressor for recompression before re-entering polymerization autoclaves.

Screw conveyors below separators homogenize, work and force semi-plastic polyethylene through extruder to form a continuous rod shape. Water bath cools and solidifies extruded rod; cutters chop solid rod into ⅛-in. cubes. These are pneumatically conveyed to storage hoppers and blenders.

▶**Checking Quality Control** — Pneumatic pipe carrier rushes polyethylene samples, department-store style, to control laboratory. Here, polymer product is checked against

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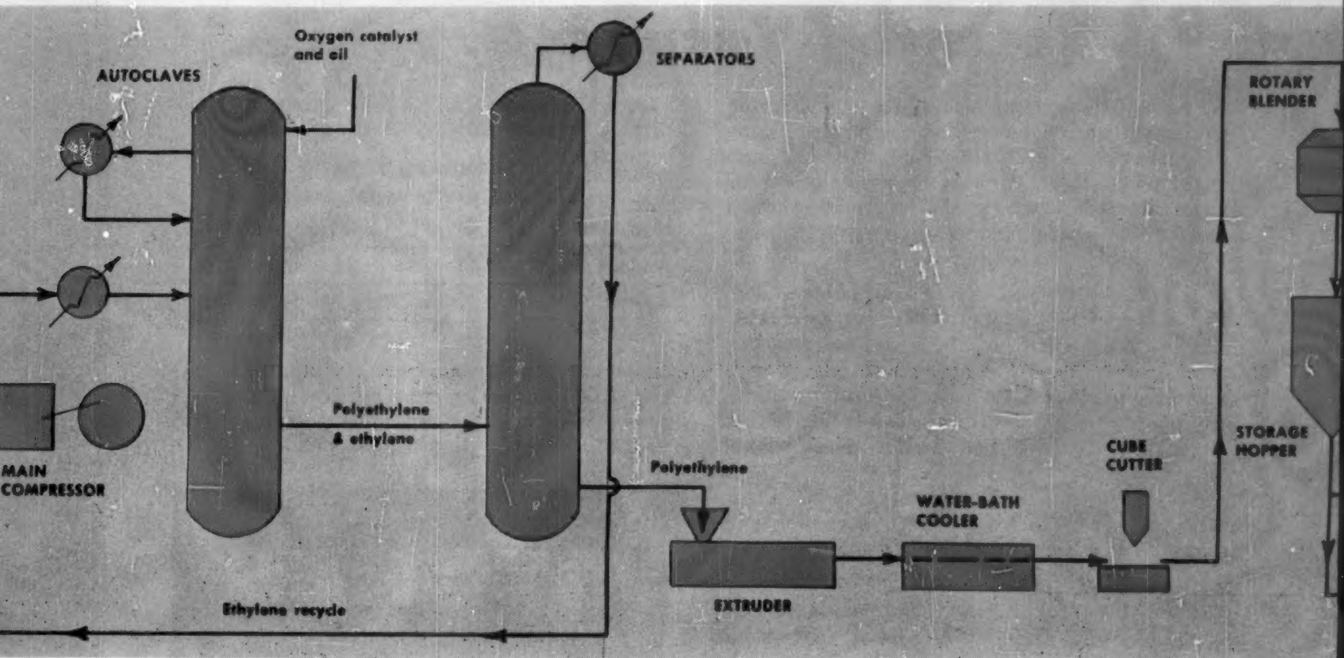

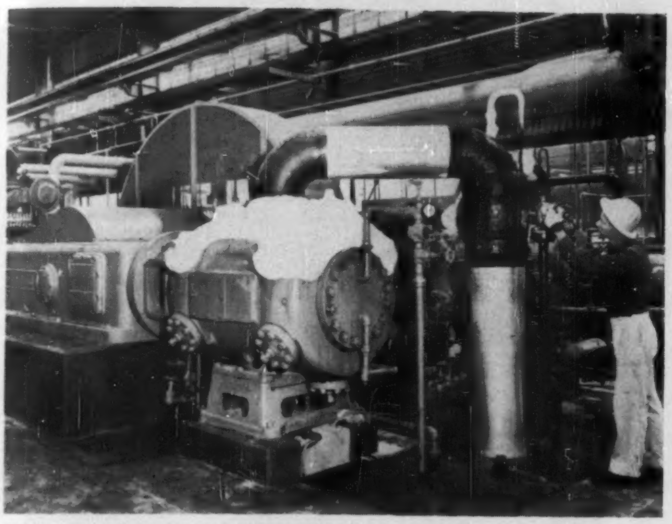

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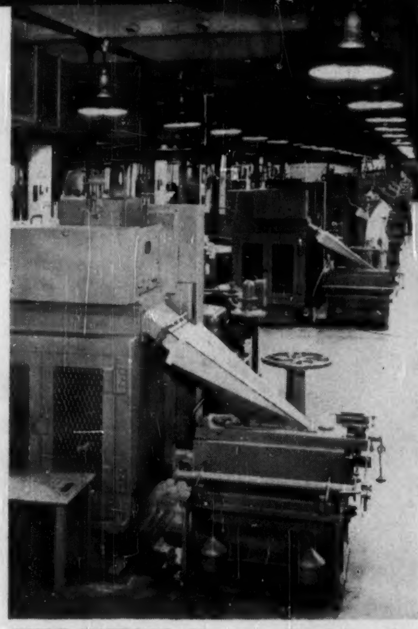

CUBE CUTTING: Choppers slice ⅛-in. cubes from the extruded and solidfied poly-rod.

BLENDI
homogeni

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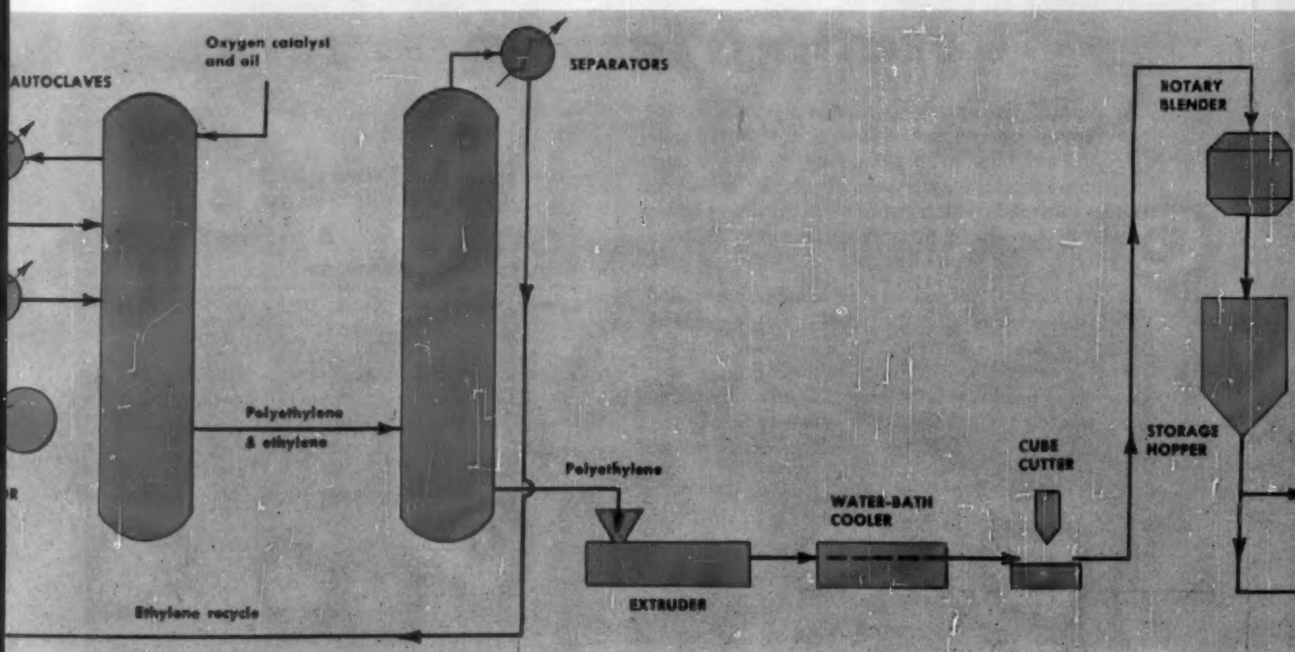
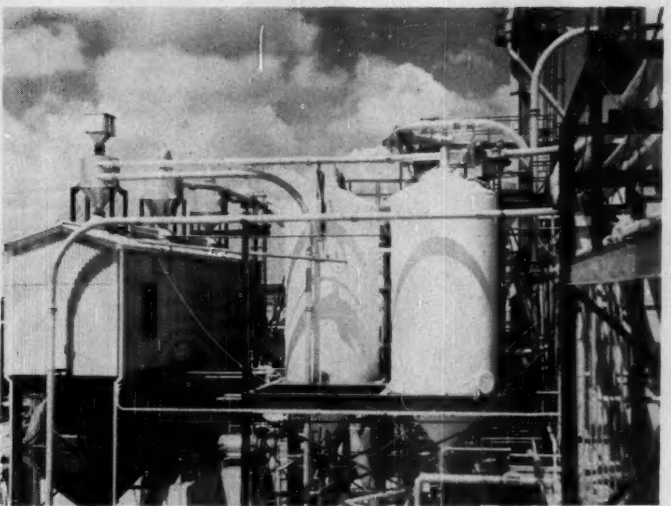




BLENDING AND STORING POLYETHYLENE: Rotary blenders homogenize cubed polymer product. Hoppers maintain inventory.

STORING POLYETHYLENE PRODUCT: Silos hold the product till it is packaged.

ppearance, purity and average-nolecular-weight specifications.

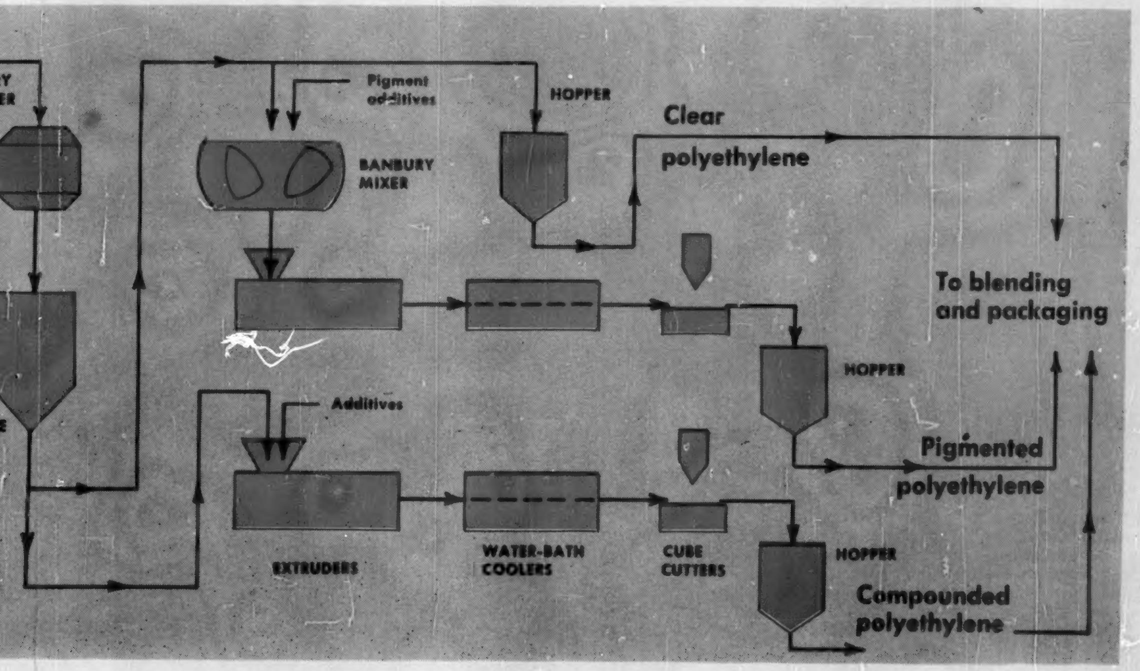
Approved polymer may be mar-eted as-is or blended with addi-ives to improve or protect its prop-rties. Pneumatic conveyor carries olymer either to bagging hopper or final packaging or to additive lending area.

Banbury mixer, extruder, or both, lend additives with polyethylene. arbon black prevents radiation degradation, slip agents (lubricants) facilitate fabrication, elastomers increase strength and pigments add beauty.

▶**Reshaping Shapes** — Additive-containing polyethylene rods are then re-extruded, water-bath cooled and cubed. Cubes feed into storage hoppers, are homogenized in a rotary blender, checked for quality in the control laboratory and finally bagged.

Final polymer-handling steps are carried out in a "hospital clean" atmosphere. Built-in vacuum cleaners remove dust as compressors feed filtered air to working areas. Materials of construction were selected on basis of cleanability.

High-purity polyethylene cubes are shipped to fabricators who manufacture the myriads of polyproducts for our homes and industries.



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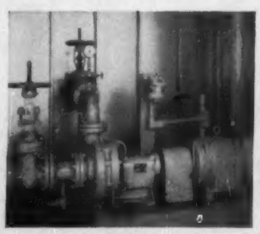

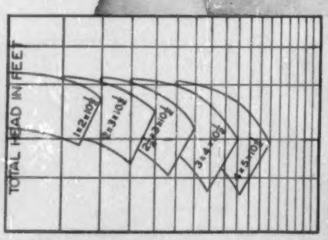

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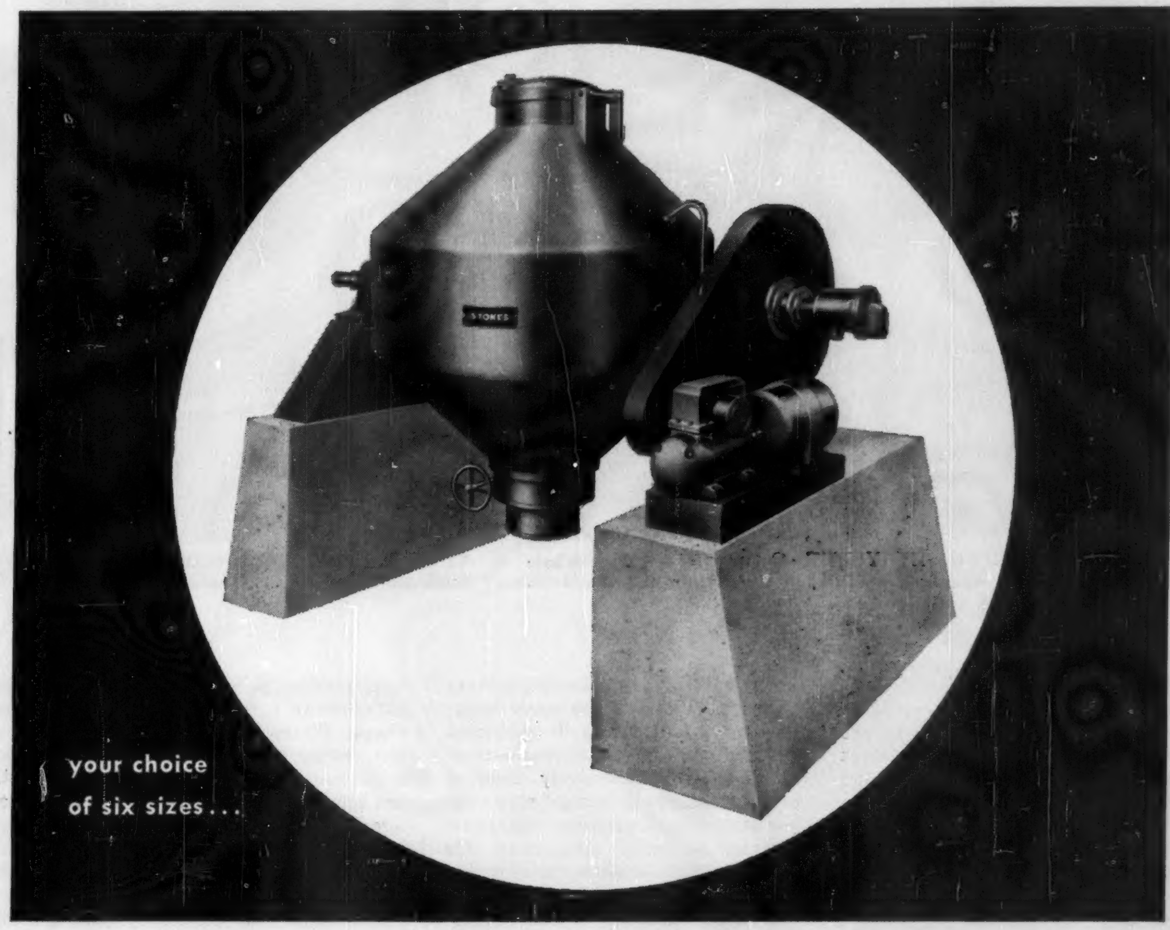
AN EXAMPLE of Peerless research is this recently released bulletin on the effects of radial loads in process pumps, "MECHANICAL CONSIDERATION IN PUMP DESIGN." Request Bulletin No. EM-79.



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STOKES

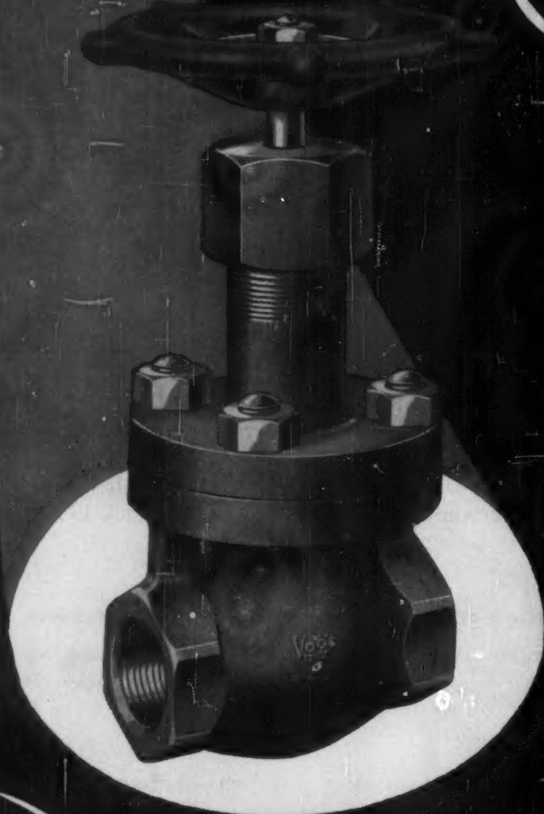
Chemical Engineering

Practice

DEC. 29, 1958

Department Index

Spotlighting 2 NEW VOGT VALVES



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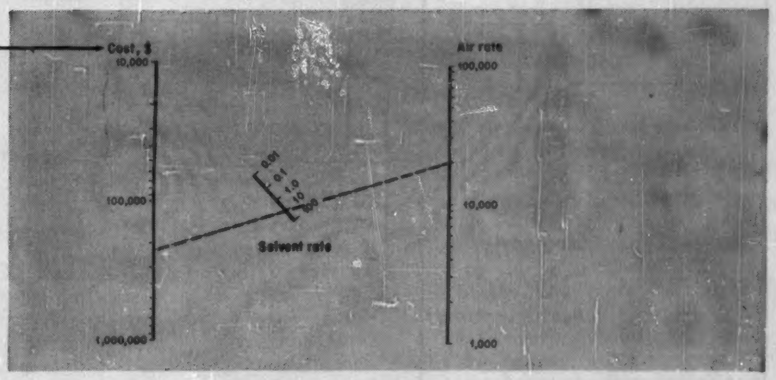
Vogt GENERAL GP PURPOSE FORGED STEEL VALVES

Chemical Engineering
DECEMBER 29, 1959

Basic Equipment Cost



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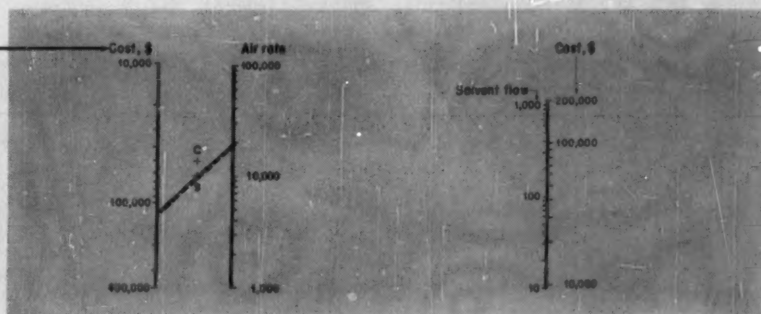
Additional Process Costs



Directly from charts. . .

Costs of Solvent Recovery Systems

For activated carbon systems, rough estimates of plant and operating costs can be made easily by engineers.

H. L. BARNEBEY and W. L. DAVIS, Barnebey-Cheney Co., Columbus, Ohio.

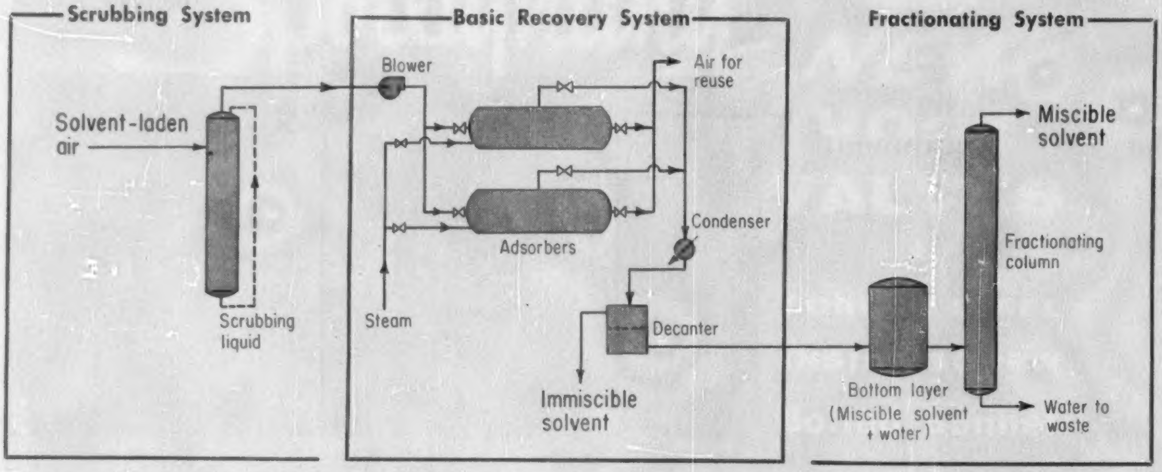
SOLVENT recovery by activated carbon adsorption was first introduced in about 1922 and has since grown to become a process step of great economic importance. Air, laden with solvent vapors in concentrations from a few parts per million to 100% solvent vapor, is passed through beds of activated carbon, with subsequent steam distillation of the solvent from the carbon bed.

We show here cost data which permit a quick, approximate estimate of capital costs, operating costs and economic benefits of activated carbon solvent recovery systems. These data can form the basis for preliminary economic evaluations.

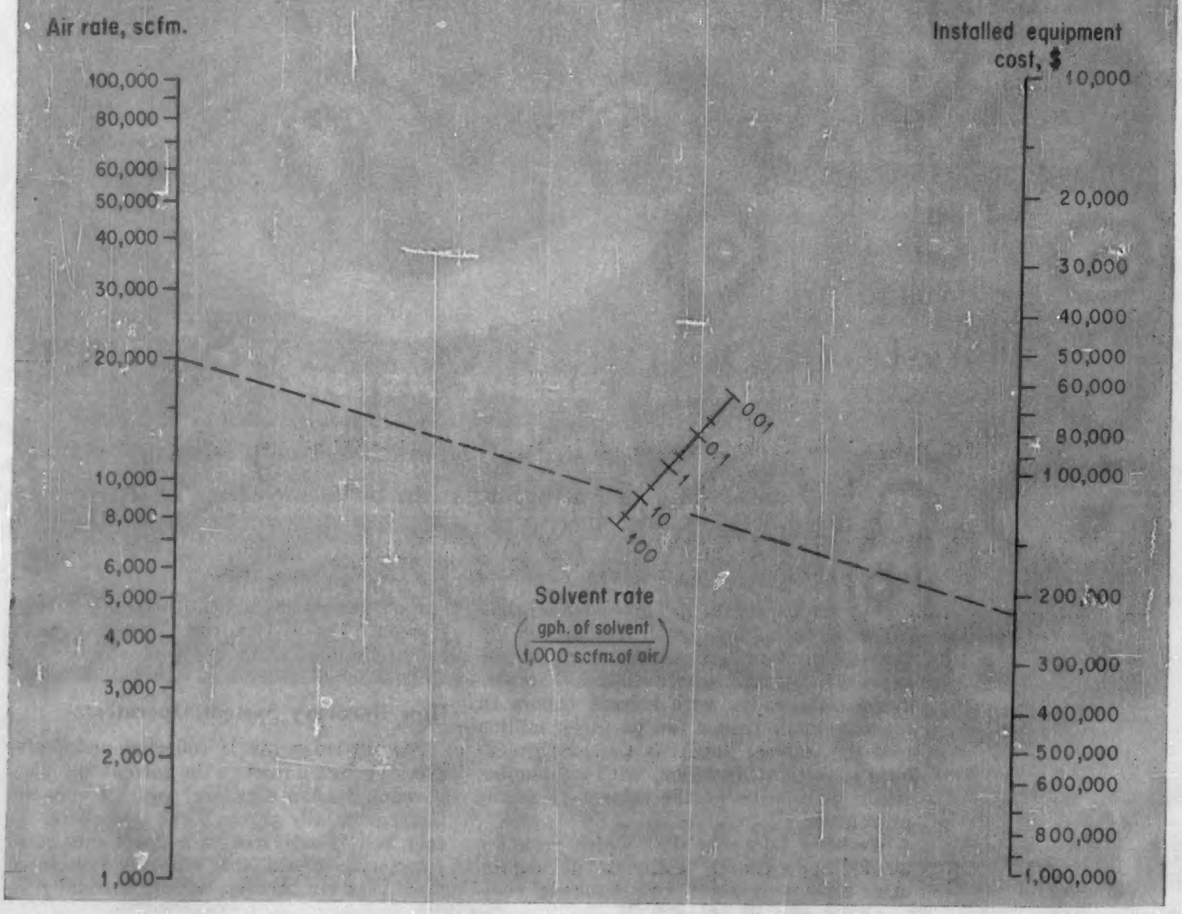
How Recovery System Operates

Solvent-laden air is collected and delivered through a duct to the solvent recovery blower (see flow diagram) which forces the air sequentially through the adsorbers. As each bed of activated carbon becomes saturated with solvent, that adsorber is isolated from the air stream—either manually or

Solvent Recovery System



Basic Plant Cost



automatically—and steam is admitted to steam-distill the solvent from the carbon bed.

This steam-solvent vapor mixture passes to the condenser where the vapors condense, forming a single or multiphase system depending on the physical nature of the solvent.

If the solvent is water-immiscible (e.g., hexane), the two layers of condensate are separated in a decanter, the solvent layer passing to storage, the water layer flowing to the sewer.

In the case of a miscible solvent (e.g., ethanol), the decanter is eliminated, condensate passing through intermediate storage to a fractionating column where the water is separated from the solvent.

For a mixture of a water-miscible solvent and a water-immiscible solvent, the condensate from the main condenser passes to a decanter which separates the two layers. The top layer (normally called the solvent layer) is generally stored for reuse without further treatment. The bottom layer, containing the water-miscible solvent, flows by gravity to intermediate storage and then to the fractionating column for dehydration.

Cost of Solvent Recovery Plant

To calculate the approximate installed cost of a solvent recovery system for most applications, the following basic information is required:

- Volume of air to be processed, in standard cu. ft./min. (scfm.). Standard conditions are 29.92 in. Hg pressure and 70 F.
- Quantity of solvent to be recovered, in gallons per hour (gph.).
- Physical and chemical nature of solvent or solvent mixture to be recovered.
- Contaminants present in the air stream, if any.

Basic Plant Cost—This item includes the cost of an automatic system of steel construction, comprising dust filter, air cooler, blower, adsorbers, condenser, decanter (or run-down tank), interconnecting pipe, valves and fittings. It includes equipment installation costs but no building or collection system for the solvent-laden air.

On the Basic Plant Cost nomograph, connect the system air flow rate in scfm. with the recovered solvent flow rate in gph./1,000 scfm. air, and read the installed equipment cost.

Additional Cost Factors—Scrubber: If contaminants (high-boiling plasticizers, phenols, acids or oil vapors)—which might plug the carbon bed or cause corrosion—are present in the air stream in significant quantities, they must first be removed in a scrubber system.

The cost of a scrubbing system is a function of the volume of air processed, in scfm. The scrubber cost is found on the Additional Plant Costs nomograph (p. 54) by connecting the system air flow rate (scfm.) with the point marked "Scrubber" and reading the installed cost of the system.

Corrosion: Certain types of solvents tend to hydrolyze and form acids when desorbed from carbon. Ketones, esters and chlorinated compounds are known offenders. Electrolytic corrosion is always a possibility whenever activated carbon and an electrolyte are present in the same system.

If corrosion is anticipated, stainless-clad adsorbers and stainless solvent process lines must be used, except in the case of chlorinated solvents where glass-lined equipment and Pyrex-brand pipe is recommended.

When corrosion is a factor, additional cost for stainless steel equipment is found by connecting system air flow rate (scfm.) with the point marked "Corrosion" and reading the installed cost on the Additional Plant Costs nomograph (p. 54).

Fractionation: If the solvent to be recovered is soluble in water, provision must be made to separate the components making the solvent available for sale or for reuse.

Assuming that simple fractionation will accomplish the required separation, the fractionating system installed cost is read from the adjacent-scale chart (p. 54) at the required solvent flow rate, gph.

Complex distillation problems are sometimes encountered when separating two solvents, or when dehydrating a single solvent beyond the degree produced by the azeotrope. If such conditions arise, the fractionating cost should be multiplied by a factor of 1.5 to 2.5, depending on the actual complexity of the problem.

Total System Costs—The sum of the basic plant cost plus the additional equipment costs, as required, gives the total estimated cost of the installed system. To revise these costs at a later date, we recommend making them proportional to the Marshall and Stevens industry average equipment cost index, which was 230 when this article was prepared.

How to Estimate Operating Costs

The Operating Costs table lists recovery costs for typical solvents of the water-immiscible type (toluene or gasoline), of the water-miscible type (alcohol or acetone) and of solvents that cannot be separated by simple distillation (a mixture of naphtha, methyl ethyl ketone and isopropanol).

The recovery cost will also vary with the over-all recovery efficiencies, the size of the installation and the chemical characteristics of the solvent. Therefore, low, average and high costs are given.

The figures in this table represent only the direct costs, including labor at $2.50 per hr., steam at $1.25 per 1,000 lb., water at $2 per 1,000 cu. ft. and power at $0.0175 per kw. The costs do not include such items as overhead, amortization of the equipment or taxes.

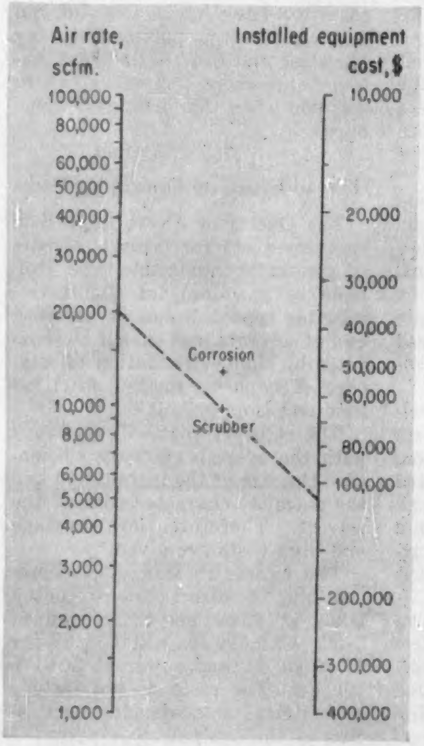
In selecting the proper recovery cost figure, several factors should be given considerations: (1) If high-boiling solvents are to be recovered (boiling range of 200-250 F.), it is advisable to use the high cost of recovery figure as given. (2) If low-boiling solvents are to be recovered (125-175 F.), it is best to select the low figure. (3) If the solvent concentration in the air stream is high (0.3% by volume or higher), recovery costs will be lower, and conversely, for low concentrations (less than 0.3%), recovery costs may be high. (4) If a scrubber is required, or if fractionation is indicated, the recovery cost will be proportionately higher.

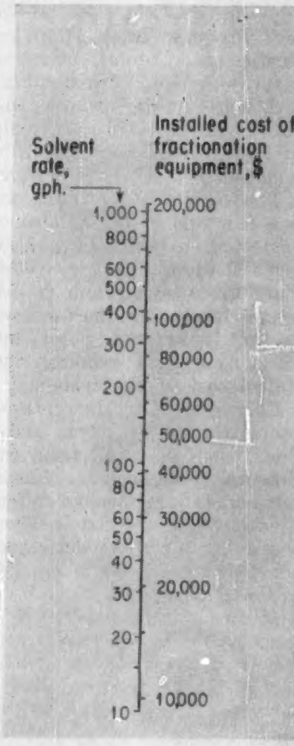
It is also true that the "per gallon" cost of recovery in a large system that recovers thousands of gallons per 24-hr. day will be less than the recovery cost in a small system that operates 8 to 10 hr. per day and recovers only a few hundred gallons daily.

Example Illustrates Method

Here is a hypothetical, but typical, example of a plant operation which needs solvent recovery equip-

Additional Plant Costs





Operating Costs

Basic Costs, Dollars/Gallon

	Relative Cost of Operation		
	Low	Average	High
Solvent immiscible in water (decantation)	$0.015	$0.025	$0.040
Water-miscible solvent (simple distillation)	0.035	0.060	0.080
Mixed solvent (complex distillation)	0.050	0.080	0.100

Modifying Cost Factors, Dollars/Gallon

	Add	Subtract
Scrubber required	$0.01	
High solvent concentration (0.3% by vol. or more)		$0.02
Low solvent concentration (less than 0.3% by vol.)	$0.02	

ment. Cost of the equipment and operating costs are determined and the various advantages, benefits and economies are considered.

In a certain process, denatured alcohol is evaporated along with small amounts of phenol, formaldehyde and traces of hydrochloric acid. The solvent loss is 4,800 gal. of alcohol per 24-hr. day, and the plant operates 5 days per week. The air stream carrying the solvent flows at the rate of 20,000 scfm.

What is the estimated installed cost of a solvent recovery system? What will the system cost to operate? What are the benefits to be expected from the operation of the recovery equipment?

The quantity of solvent to be recovered, in gph./1,000 scfm., is: $4,800/(24 \times 20) = 10$ gph./1,000 scfm. Because of the nature of the solvent, a fractionating system will be required to produce 95.5% alcohol. In addition, phenol, formaldehyde and HCl must be removed by a scrubbing system.

System Cost—To determine the basic cost of the equipment, connect the points 20,000 scfm. and 10 gph./1,000 scfm. on the Basic Plant Cost nomograph and read the installed cost as $215,000.

Each of the modifying design factors must now be considered:

Scrubber: Since small amounts of phenol and formaldehyde might be adsorbed in the carbon and might polymerize there, they must be removed prior to the adsorption system. A countercurrent scrubber with caustic solution will effectively remove these contaminants from the air stream and at the same time neutralize trace acid material.

Here, a line through 20,000 scfm. and the point marked "Scrubber" on the Additional Plant Cost nomograph gives a cost of $110,000 for the scrubbing system.

Corrosion: Since the scrubber neutralizes the hydrochloric acid, and no solvent breakdown is expected, no factor need be added for stainless steel equipment.

Fractionation: Denatured alcohol is miscible with water and a 35% solution of alcohol in water will be produced when a carbon bed is steamed. This product must be fractionated to produce a reusable 95% denatured alcohol.

The solvent recovery rate is: $4,800/24 = 200$ gph. Read on the adjacent-scale chart for fractionation cost factor at 200 gph., the cost for fractionation equipment of $66,000.

The total installed cost of this solvent recovery plant is then:

Basic cost	$215,000
Scrubber system	110,000
Corrosion cost	0
Fractionation system	66,000
Total cost	$391,000

Operating Cost—The cost of operation will be somewhat higher than average, since a scrubber is necessary. Referring to the Operating Costs table, the average recovery cost of a miscible solvent is $0.06 per gal.; this is revised upward $0.01 per gal. (to cover scrubber operation) to give a cost of operation of $0.07 per gal.

Advantages and Their Values

For our example, we've listed and attempted to evaluate the benefits obtainable from a solvent recovery system.

Recovered Solvent Value—Inasmuch as alcohol would normally be purchased in tank car quantities, the price of denatured alcohol SD-1 would be about $0.50 per gal.

To find the economic justification for the investment before amortization and taxes, the yearly return is determined as follows:

Value of solvent, $/gal.	0.50
Cost of recovery, $/gal.	0.07
Net value of recovered solvent	$0.43
Gal. of solvent used/yr.	1,235,500
Gal. of solvent recoverable/yr. (based on 80% recovery)	988,400
Yearly net operating income of solvent recovery system	$425,000

Increased Safety—The adsorption of 200 gph. of denatured alcohol from the discharge air stream represents a greatly improved operating condition from a safety standpoint. Under certain conditions, it is possible to obtain reduced fire insurance rates by the use of a solvent recovery system.

The installation of an approved fume recovery system can permit a credit of as much as 30% on the base building insurance rate. For a fireproof structure, the base building rate is about $0.20 per $100 evaluation per year.

Assuming the building to be valued at $1,000,000, the 30% credit amounts to a savings of $600/yr. in reduced premiums.

A second important advantage is elimination of fire hazards. To a plant producing $5,000,000 in product annually, a single day's loss of production would mean a loss of $20,000 gross business, with the overhead and profit amounting to an additional estimated $6,000.

Though most fires cause business interruption for more than one day, for this example it is assumed that the installation of a solvent recovery system will save the overhead and profit caused by a fire resulting in a one-day-per-year business interruption. Thus, we can charge this saving of $6,000 annually as a benefit to the system.

Improved Working Conditions—It is difficult to assign a dollar value to the effect of increased production and decreased corrosion. But, if the factory employs 75 workers at an average salary of $4,000 annually, then an increase in productivity of 5%—due to improved working conditions—would amount to $15,000 annually in equivalent salary.

Pollution Elimination—A flow rate of 200 gph. of ethanol represents a considerable amount of solvent to be contaminating the atmosphere 24 h[illegible] per day, 5 days per week. The recovery of this solvent will stop pollution and improve neighborhood relations.

In assigning a value to the economic benefit of pollution control, it is evident that benefits derived may vary from a few thousand dollars a year for industrial and public relations costs to several million dollars which might be required if it became necessary to shut down the operation or move the plant to another location.

It seems reasonable to assign a value equal to 0.1% of the annual product value, or $5,000 here.

Lower Inventory—In our example, we will assume that the reduction in required inventory releases three 20,000-gal. storage tanks for other uses. Also, it is no longer necessary to carry a two weeks' supply of 50,000 gal. of alcohol on hand all the time.

Assuming the 50,000 gal. of alcohol has a value of $25,000, then the annual interest rate (at 6%) on this amount would be $1,500. Release of storage tanks, pumps and piping for other uses can be assigned a value of $500 annually, making a combined annual benefit of $2,000.

Plant Operation Index—Many solvent recovery users have found that the recovery operation gives them an excellent check on many phases of their factory operation. A decrease or increase in the amount of solvent recovered, or a change in the composition of the solvent may indicate altered manufacturing methods.

To an operation producing a product of $5,000,000 gross value yearly, operational losses can easily equal as much as 5% of the product value. For this estimate, a figure of 1% is taken, amounting to $50,000 per year.

Air Recovery—Should it prove desirable to do so, the stripped air may be returned to the operating area for reuse. Such a procedure would save heating costs in winter and cooling costs in summer.

For our example, we have assumed that the average winter temperature is 40 F., and that the 20,000 scfm. of air can be returned to the operating area at 90 F. after the solvent is removed.

If the average heating season is six months long, about 3,400 million Btu. may be saved. At $0.52 per Mcf. of gas and for an 80% heat conversion efficiency, it is possible to save $2,000 per year by returning the air to the operating area in the winter.

Product Improvement—If a solvent recovery system is installed, it then becomes feasible to alter solvent content, or even change the solvent itself, in order to produce a better product.

It is not easy to assign a dollar value to a condition which may improve the quality of a product to the extent that there is no longer any competition. However, for example purposes, an annual value of $100,000 is assigned.

Total Benefit Value—Summing the dollar values of all benefits, we arrive at the following:

Recovered solvent value	$425,000
Increased safety	6,600
Improved working conditions	15,000
Pollution elimination	5,000
Lower inventory	2,000
Plant operation index	50,000
Air recovery	2,000
Product improvement	100,000
Total annual benefit	$605,600

Considering just those items whose values can be tangibly evaluated (recovered solvent value, lower inventory and air recovery), the annual benefit would be about $429,000. This represents an attractive return on an investment of $391,000.

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Corrosion

REFRESHER ON CAUSE AND CURE

Where equipment carries molten metal . . .

Consider Nonoxidative Corrosion

Solubility and solution rates explain intergranular penetration and alloying of materials in corrosive attack by liquid metals.

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By NONOXIDATIVE corrosion we mean the type of attack in which physical solution and diffusion predominate and chemical reaction is not the major cause of destruction. This is the case in corrosive attack by liquid metals. Since transfer of electrons is not involved, the electrochemical concepts which serve so well in treating oxidative corrosion are not applicable here. Instead we must look to principles which control solubility and solution rate to explain nonoxidative corrosion.

Usually we encounter several complicating factors, such as surface films, impurities and temperature gradients, which influence both solution rate and the attainment of solubility limits. Although, nonoxidative corrosion, in recent years, has been the subject of considerable research effort, our knowledge of the interaction of the various phenomena is still rather limited. Hence precise prediction of nonoxidative corrosion rates is difficult and often impossible.

While the handling of liquid metals in refractory containers is commonplace in the metallurgical industries, only recently have chemical engineers become interested in problems involving the flow of liquid metals in metallic systems. The advent of nuclear technology has brought new uses for liquid metals. Several liquid metals fuels have been proposed for reactor design,[1] including uranium-bismuth, uranium-lead-bismuth, uranium-lead-tin and thorium-magnesium.

Liquid metals are also under consideration as heat transfer fluids in nuclear reactors and other high temperature applications. The best metals[2] for this purpose are lithium, sodium and potassium because of their low melting points, high boiling points and excellent heat transfer properties. The corrosiveness of all these fluids toward common materials of construction restricts their development.

New uses for alkali metals in the chemical industry[3,4] further emphasize the need for a better understanding of liquid metal corrosion. Some of the new applications are lithium hydride as a starting material in the production of boron fuels and other organo-metallic compounds; lithium, sodium or potassium dispersions as diene polymerization catalysts and lithium-aluminum-tetraalkyls as catalysts in low pressure ethylene polymerization.

The best available compilations of liquid metal property data[5,6,7] are presented in the "Liquid Metals Handbooks" and the "Engineering Materials Handbook." Cottrell and Mann[8] summarize the practical techniques for handling alkali metals. Unfortunately much of the corrosion data presently available is still qualitative and many gaps in our knowledge still exist.

We know that several types of corrosive attack occur when liquid metals contact solid metals. Manly[9] lists these as follows:

- Simple solution.
- Alloying between liquid metal and solid metal.
- Intergranular penetration.
- Impurity reactions.
- Temperature-gradient mass transfer.
- Concentration-gradient or dissimilar-metal mass transfer.

Variables affecting these phenomena are temperature level, temperature gradient, cyclic temperature fluctuations and surface-to-volume ratio. Additional factors include liquid metal purity, liquid metal flow rate and solid metal characteristics such as surface condition, composition and metal structure.

Since separate control of these factors is difficult to achieve, we see that design of corrosion tests and quantitative interpretation of the resulting data are not simple matters. Most of the tests reported in the literature determine the performance characteristics of specific container materials rather than at fundamental study of mass transfer effects. However, we can at least determine qualitative conclusions about these effects.

Two operating variables of principal interest to the design engineer are temperature and flow rate.

*To meet your author see *Chem. Eng.*, Nov. 17, 1958, p. 154.

We know that as temperature increases both diffusion rates and the solubility of the solid metal in the liquid metal will increase. When a temperature gradient exists in a liquid metal system, we can expect solubility differences between the hot and cold areas to cause mass transfer.

Cyclic variation of temperature at any one location or in the entire system can cause alternate solution and precipitation, particularly when solubility varies sharply with temperature. Manly[9] cites experience with the copper-bismuth system. In this system at 500 C., corrosion rate is several times faster when the cyclic change in temperature is ± 5 C. than when the change is ± 0.5 C.

Fluid motion plays the same role in nonoxidative corrosion that it does in other diffusional operations. Increasing flow rate aids mass transfer and reduces effective thickness of interfacial films. A study of mass transfer coefficients[10] for the solution of several different metals in liquid mercury shows that the coefficients follow the same general correlations developed for liquids. However, reliable data are still lacking for other corrosive metals. At exceptionally high flow rates, we can expect erosion effects to become important particularly if precipitated metallic crystals become suspended in the flowing metal.

The ratio of exposed solid metal surface area to volume of liquid metal may be an important factor in establishing corrosion rate in static systems or ones in which the liquid metal is recirculated. In such cases the solid metal may corrode sufficiently to approach saturation in the liquid metal. Consequently, corrosion increases as the ratio of surface area to volume decreases.

Surface condition of the solid metal is important in the initial stages of operation prior to the establishment of steady state conditions. However, surface condition can affect corrosion test results, particularly if the tests are of short duration. Furthermore, impurities such as oxides and nitrides introduced on the solid metal can alter corrosion rates. The effect of these impurities is most noticeable with the molten alkali metals.

Composition of the exposed surface and the metallurgical structure of each component are important factors throughout the period of exposure. If more than one solid metal is exposed to the liquid metal, then dissimilar metal mass transfer occurs. Under this condition, the corrosion rate generally increases.

Grain size affects corrosion[9] because wettability of individual grains is different from that of the grain boundaries. Grain boundary structure is also a variable since the presence of carbides or oxides can accelerate intergranular attack. Finally, as in electrochemical corrosion, local stresses must be considered, since they can modify surface structures and affect solution tendencies.

Types of Liquid Metal Attack

The most elementary case is the simple solution type where the metal surface corrodes uniformly at a substantially constant rate. If the phase diagram for such a system is known, the extent of corrosion and depth of attack can be predicted readily from the solubility limit at the prevailing temperature. The rate of attack must be measured experimentally or estimated from a knowledge of mass transfer coefficients at the conditions of exposure.

However, system impurities can modify corrosion rates substantially even in cases of simple solution attack. Uniform corrosion occurs primarily with pure metals, although it has also been observed with rather complex alloys[8] such as Type 304 stainless steel in molten sodium.

When solution of the liquid metal is possible in the solid metal, alloying may occur. The extent of this type of attack is also predictable when the phase diagram is known. However, corrosion rate is more difficult to estimate than in simple solution attack because we must know the diffusion rates in the solid phase.

When the solid phase contains more than one component, entry by the liquid metal is likely to displace one of the components of the original alloy. Alloying attack has been observed in the corrosion of vanadium by lead, copper by sodium and type 446 stainless steel by lead. The last of these examples is shown in Fig. 1.

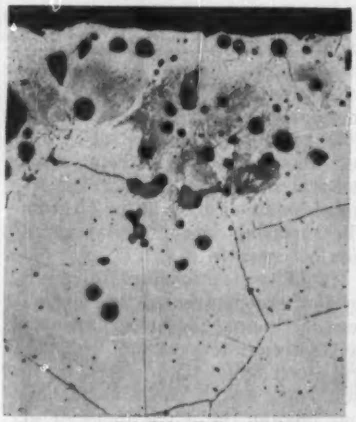
Selective solution of one component from an alloy causes intergranular penetration. Eventually disintegration of the alloy structure occurs. Alloys[2] in which one constituent segregates at the grain boundaries are particularly susceptible to this type of attack. The best known example is the selective removal of nickel from austenitic stainless steels by lead or lithium. The resulting intergranular corrosion is shown in Fig. 6.

Impurity reactions are difficult to predict except from actual experience. Principal impurities are oxygen, nitrogen and carbon. Not only will such impurities affect corrosion rates but in some cases they may change the whole mode of attack[8] because of the reactivity of the impurity or its effect on surface tension. Even minute quantities can cause serious difficulties. Experimental delineation of impurity effects is almost impossible because of analytical limitations.

The influence of nitrogen on corrosion of type 316 stainless steel in lithium is a good example[2] of impurity effects. After 100 hr. exposure to pure lithium at 870 C., attack is slight (about 0.002 in). But upon addition of only 0.1% nitrogen to the lithium, the full thickness (0.035 in.) is penetrated as shown in Fig. 2 for the same exposure conditions. In this instance, the attack mechanism[2] is reaction between lithium nitride and the carbides which form the grain boundary network.

Oxide impurities are difficult to avoid in alkali metals. Their oxides are extremely stable and alkali metals reduce surface oxides present on container metals. The presence of oxide impurities in sodium has been found to increase precipitation in cold sections of nickel alloy and stainless steel systems. Carbon impurity in sodium or lithium can result in severe carburization of high temperature alloy.

Since most liquid metal systems show rather steep solubility curves and isothermal operation is difficult to achieve even when desired, temperature-gradient mass transfer occurs. In this type of attack, we define temperature-gradient mass transfer as the solution of metal in warmer locations and its precipitation in colder locations in a system. Thus, not only is corrosion accelerated but cold-zone precipitation can lead to plugging of circulating systems.



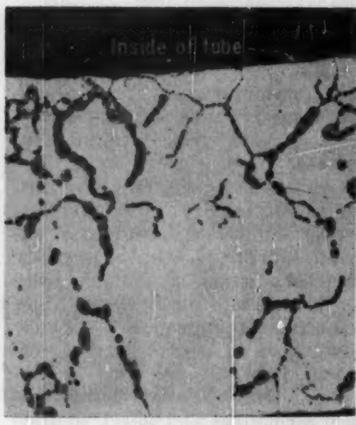
*Oak Ridge National Laboratory**

Alloying **Fig. 1**

Liquid metal: Lead at 1,000 C.

Specimen: Type 446 stainless steel.

Result: After 400 hr. immersion, lead diffuses into alloy along grain boundries.



Impurity Reactions **Fig. 2**

Liquid metal: Lithium with 0.1% Li_3N at 870 C.

Container: 316 stainless steel tube.

Result: After 100 hr. exposure to lithium, nitride impurity reacting with carbides along grain boundaries causes failure of tube.

Temperature Gradient **Fig. 3**

Liquid metal: Lithium at 1,000 C.

Specimen: Type 410 stainless steel thermal convection loop.

Result: After 40 hr. operation, lithium dissolves iron from hot part of loop and carries it to colder section where iron precipitates.

Mass transferred metal may nucleate in the bulk liquid or on piping walls as shown in Fig. 3. Over-all corrosion rate in a system with a temperature gradient will be determined by the relative rates of solution in the hot zone and precipitation in the cold zone. With molten lead circulating in thermal convection loops, the rate controlling step is found to be solution in the hot zone. Formation of diffusion barriers[11] reduces plugging in the cold zone.

The last type of liquid metal corrosion is concentration-gradient mass transfer. This is caused by exposure to the corroding fluid of dissimilar solid metals capable of alloying with each other or forming solid solutions. One solid metal is dissolved by the liquid metal and conveyed to the other metal surface where it deposits. For example, sodium transfers nickel in this way to molybdenum surfaces as shown in Fig. 4.

We must consider concentration-gradient attack not only in designing liquid metal transfer systems but also in performing corrosion tests. The marked increase in corrosion of type 304 stainless steel is evident when we compare Figs. 5 and 6.

Manly[9] suggests that tendency toward mass transfer attack can be predicted from large differences between the chemical potentials or high mutual solubility of two solid materials.

Liquid Metal Corrosion Tests

At this point it is appropriate to comment on liquid metal corrosion tests. There are three basic categories: (1) static screening tests, (2) dynamic performance tests and (3) fundamental studies of solubility and mass transfer. Considerable work has been done in the first two categories, resulting in an encyclopedic accumulation of data. These data can be interpreted and correlated only qualitatively. Rarely have different groups of tests been run on the same basis and almost always no attempt was made to control impurities.

Much of this testing was done in connection with the development of nuclear reactors and many of the results are still unavailable in the open literature. However, we hope that these data will be declassified soon. A few fundamental studies have been published. More work is needed before we can understand mass transfer phenomena in liquid metals as well as we do analogous processes in ordinary liquids.

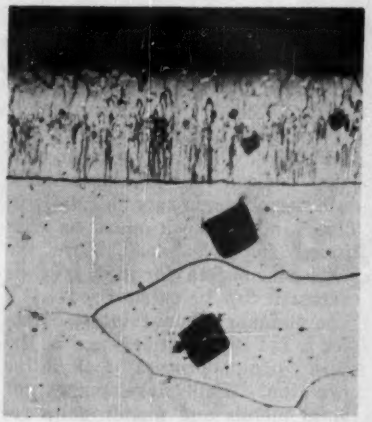
Static tests are usually performed by sealing samples of liquid metal into small capsules of test metal or by suspending test metal specimens in a closed vessel containing liquid metal. After a desired period of exposure at a controlled temperature, the results are determined by chemical, metallographic or mechanical testing of the specimens.

Chemical analysis of the corrosive liquid metal, though desirable, is often omitted because of analytical difficulties. Use of multiple samples and statistical treatment of data are helpful since results are not always wholly reproducible.

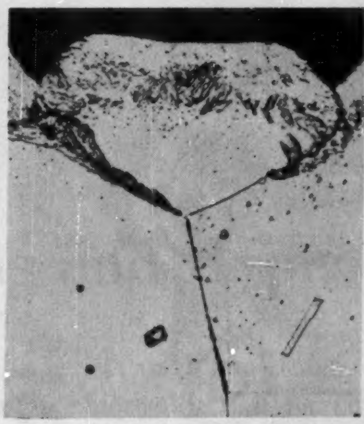
Specimen weight-change data are likely to be misleading. Contrary to the usual result in oxidative corrosion, weight loss does not always occur in corrosion by liquid metals. Even in severe cases of intergranular corrosion, weight changes may be essentially negligible.

Miller[12] suggests microscopic examination as the best single technique for evaluating attack by liquid metals. Microscopic examination permits ready differentiation between different types of attack and identification of attendant phase changes. Quantitative measurement of intergranular phenomena, diffusion layers and extent of material removal is possible

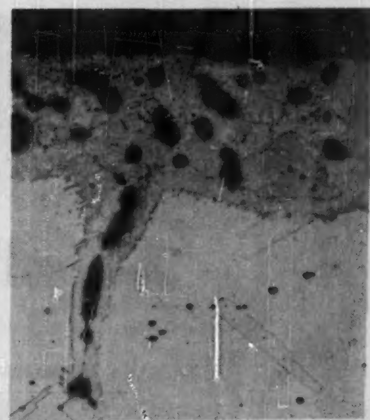
*All photographs courtesy of Oak Ridge National Laboratory.



Concentration Gradient Fig. 4
Liquid metal: Sodium at 1,000 C.
Container: Nickel
Specimen: Molybdenum
Result: After 100 hr., nickel dissolves in sodium. Sodium carries nickel to molybdenum surface where inter-alloying occurs.



Dissimilar Metal Transfer Fig. 5
Liquid metal: Lithium at 1,000 C.
Container: Type 304 stainless steel.
Specimen: Type 304 stainless steel.
Result: After 400 hr., only slight attack occurs at grain boundaries of test specimen.



Dissimilar Metal Transfer Fig. 6
Liquid metal: Lithium at 1,000 C.
Container: Iron
Specimen: Type 304 stainless steel.
Result: After 400 hr., removal and transport of nickel to iron container causes severe attack along grain boundaries of specimen.

microscopically. Sometimes X-ray analysis is used.

Static tests are rapid, relatively inexpensive and best for general screening of available container materials for possible use with a given corrosive metal. However, their results do not always correlate with those obtained in actual service. For this purpose dynamic tests simulating intended service conditions such as flow rate, temperature level and gradient are best. Both thermal convection and forced circulation loops are used in dynamic tests.

Conventional pumps are usually unsatisfactory for handling liquid metals. Fortunately their electrical properties make possible the use of electromagnetic devices for pumping and flow measurement in corrosion test loops and in large scale application.[1, 8, 9]

Our earlier discussion of types of attack makes it evident that several precautions are necessary to assure validity of corrosion tests. First, the metallurgical history and surface preparation of the test specimen should be carefully controlled and consistent with test objectives. Second, the container should be made of the same material as the test specimens or of known inert material thus minimizing undesirable mass-transfer effects. Third, protective atmospheres must be truly inert. With active alkali metals, the best way to purify a blanketing gas is to bubble it through a separate container of the liquid metal.

Finally, impurities in the liquid metal should be known and, so far as possible, controlled. This is extremely important since many inconsistencies[9] in liquid metal corrosion data can be traced to impurity effects.

As noted above, fundamental study of mass transfer phenomena has only begun. Dunn, Bonilla and co-workers[10] investigated mass transfer of several metals in mercury. Ward and Taylor[13] reported rate constants for the solution of copper in lead and bismuth.

Epstein[14] has made a mathematical study of the problem and preliminary analysis of available data on alkali metals. He points out that the usual liquid correlations familiar to most chemical engineers are applicable only to systems controlled by diffusion in the bulk stream. Mercury systems are of this type but Epstein has found that in lithium and sodium systems mass transfer rates are controlled by solution processes at the solid-liquid metal interface.

A study of mass transfer[15] in liquid lithium sponsored by the National Science Foundation is presently under way at Syracuse University. This work employs a forced-circulation system designed to permit measurement of solution rates in a heated zone and deposition rates in a cooled zone. A flow sheet of the test loop is given on the next page.

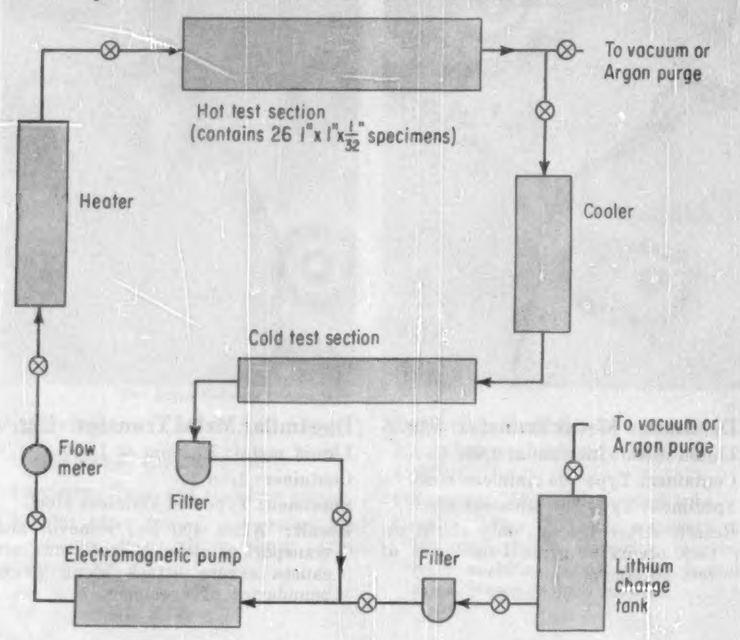
More fundamental work of this kind is urgently needed, first, with pure liquid metals and, then, at known impurity levels to establish the role played by contaminants. Mass transfer in liquid metals may become an important area of chemical engineering in the near future.

How to Control Corrosion

Understanding corrosion mechanism is the key to its effective control. For the present, our principal means of controlling liquid metal corrosion is to use construction materials which we know are resistant. Some thought is being given to the development of inhibitors. Taylor[16] suggests these may be of two types: scavengers to remove impurities or film-forming substances to set up diffusion barriers at solid surfaces.

Barium, strontium or calcium have been proposed as scavengers[17] for molten sodium systems and titanium[18] for lithium systems.

Test Loop Yields Data on Mass Transfer Effects



Powdered chromium and aluminum were found effective in retarding mass transfer of nickel[19] in molten caustic. We may anticipate refinement of these proposals and later still other methods of control through environment modification.

We should broaden our discussion to include nonmetallic materials and fluids. Information[7] on corrosion resistance of nonmetallic materials is given in the "Engineering Materials Handbook." Generally, ceramic materials exhibit poor resistance to molten alkali metals. Graphite resists sodium and potassium well but not lithium.

Standard references on refractories[20, 21] discuss the corrosive effects of metals and slags encountered in practice. Little research has been done to establish the fundamental mechanisms of attack. Both chemical and physical processes are possible in causing this type of attack.

Components of a ceramic or refractory may dissolve in the melt contacting it and be carried away by diffusion and bulk motion. Phase transformations can occur and attack may be intergranular in nature. Slags or nonmetallic melts are more likely to react with refractory solids than are molten metals. These complicate analysis of the problem since three phases are present. Physical properties of the solid are likely to be important. Nonporous and completely fused materials are probably the most resistant.

Norton[20] discusses the chemical reactions between refractories and slags and glasses. We know that ceramic and refractory materials are of considerable interest in jet and rocket development. We hope that some fundamental knowledge on corrosion mechanism will evolve from the research activity in this area. For the immediate present, the results of this work are likely to remain classified.

In several common chemical processes, molten salts or alkalies are handled in large quantities. However, little is known about the fundamental mechanisms by which such substances corrode materials of construction. In such cases attack may be either chemical or physical. Uhlig[22] includes some qualitative information about the resistance of metals to molten salts in his discussion of high temperature corrosion.

Three recent articles[23] report the results of a corrosion study of nickel-molybdenum-iron alloys and Inconel in molten sodium hydroxide at temperatures up to 815 C. Selective removal of iron, chromium and molybdenum was found to occur together with intergranular deposition of corrosion products including oxides and sodium oxysalts. Good photomicrographic data permit some rate calculations. This kind of work must be continued and expanded before the basic phenomena for this type of corrosion can be categorized.

In summary, nonoxidative corrosion is not as well understood as the more common process of oxidative corrosion. Full development of liquid metals and molten salts requires a better understanding of corrosion phenomena and effective methods of control. Good work is underway but the field still presents many challenging research opportunities.

REFERENCES

1. "Liquid Metals Technology," AIChE Symposium Series, 53, No. 20 (1957).
2. E. E. Hoffman and W. D. Manly, "Corrosion Resistance to Sodium and Lithium," ACS Advances in Chemistry Series, 19, pp. 82-91 (1957).
3. W. M. Fenton and others, "Uses of Lithium Metal," ACS Advances in Chemistry Series, 19, pp. 16-25 (1957).
4. F. C. Foster and J. L. Binder, "Alkali Metal Polymerization Catalysts," ACS Advances in Chemistry Series, 19, pp. 26-33 (1957).
5. R. N. Lyon, "Liquid Metals Handbook," 2nd Ed., NAVEXOS P-733, U. S. Atomic Energy Commission (1954).
6. C. B. Jackson, "Sodium-NaK Supplement," TID-5277, U. S Atomic Energy Commission (1955).
7. C. L. Mantell, "Engineering Materials Handbook," Section 16, McGraw-Hill Book Co., New York (1958).
8. W. B. Cottrell and L. A. Mann, "Sodium Plumbing," ORNL-1688, U. S. Atomic Energy Commission (1953).
9. W. D. Manly, "Fundamentals of Liquid Metal Corrosion," *Corrosion*, 12, 336t-342t (1956).
10. W. E. Dunn and others, *AIChE Journal*, 2, 184-86 (1956).
11. J. V. Cathcart and W. D. Manly, *Corrosion*, 12, 87t-91t (1956).
12. R. C. Miller, "Liquid Metals Handbook," 2nd Ed. NAVEXOS P-733, Chap. 4, U. S. Atomic Energy Commission (1954).
13. A. G. Ward and J. W. Taylor, *J. Inst. of Metals*, 85, No. 4, 145-52 (1956).
14. L. F. Epstein, "Corrosion by Liquid Metals," Proceedings of International Conference on Peaceful Uses of Atomic Energy, Geneva, Aug. 1955, 9, p. 311, United Nations (1956).
15. W. N. Gill, Ph. D. Dissertation in progress, Syracuse University.
16. J. W. Taylor, "Inhibition of Liquid Metal Corrosion," AERE-M/TN, British Atomic Energy Commission, Feb. 10, 1956.
17. J. W. Mausteller and S. J. Rodgers, Technical Report No. 41, Contract NObs 65426, Mine Safety Appliances Co., Aug. 24, 1955.
18. E. E. Hoffman, personal communication, Aug. 1958.
19. A. F. Forestieri, NACA Memo E54E19, May 21, 1954.
20. F. H. Norton, "Refractories," 3rd. Ed., McGraw-Hill Book Co., New York (1949).
21. "Modern Refractory Practice," 3rd. Ed., Harbison-Walker Refractories Co., Pittsburgh, Pa. (1950).
22. H. H. Uhlig, "Corrosion Handbook," John Wiley & Sons, Inc., New York (1948).
23. G. P. Smith, M. E. Steidlitz and E. E. Hoffman, *Corrosion*, 13, 561t-64t, 627t-30t (1957); 14, 47t-52t (1958).

How to Deal With Costs of . . .

Joint Products and Byproducts

With this article and a knowledge of process alternatives, you can help provide more objective standards for allocating product costs.

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COST systems are vital to the health and growth of any industry. They direct valuation of inventory so that profit or loss data can be made available to business owners and the tax collector. They assist in the minimization of manufacturing costs. And, they provide guidance to whoever sets product prices.

If each step of a plant operation produces only one product grade, the setting of costs is simple, as all costs can be charged against that grade. Frequently in chemical operations, however, a process will produce a mixture of several grades. Or, several alternate processes or sets of process conditions will produce various mixtures of the same grades. The problem of setting a cost on each of the several grades is one of *joint costing.*

If all grades but one are completely unusable, the problem again reduces to the simple costing of a single grade. However, an intermediate condition exists where moderate amounts of some grades are usable, but an excess still exists. Here we enter the problem of *byproduct costing.*

Note that we define a byproduct as a material that is produced coincident with the production of another, desired material, and is partially, but not completely saleable or usable.

Systems for Cost Control

For process operations that produce custom materials to meet each customer's own specifications, cost control depends on a *job cost* accounting system. Each order is individually estimated and costed. We are not considering this type of system here.

Many process operations, however, produce a standard list of saleable products for stock. Accounting procedures for these operations usually follow a *standard cost* system. In such a system, each raw material, intermediate and finished product has a standard cost, set on the basis of a budget. Actual costs are compiled and then compared with the cost standards to arrive at figures for process cost savings.

One particularly effective form of a standard cost system is the so-called *direct cost* system.[4] In this, all accounting transfers for a plant turning out intermediates or finished products are made on the basis of "direct costs." These include only the variable elements of cost such as material, direct labor, utilities and normal maintenance. All remaining text in this article applies primarily to direct cost systems.

Allocation of Joint Costs

A standard accounting text[2] lists two methods of allocating joint costs. The first is to use the same unit cost for all products.

In the second method, costs are allocated according to sales value. That is, any product which is sold to the customer for twice as much as another product is given a unit cost that is twice as high. Unit costs are adjusted to liquidate the total cost of the operation.

While these two methods possibly represent the range of alternatives for the meat-packing business, they are not always the most appropriate for the chemical business. However, a third method —the engineering alternate—is particularly applicable to chemical processing operations.

The engineering alternate system for joint costing considers that, either by introduction of alternative processes or by alteration of process conditions, it is frequently possible (at various costs) to produce varying product mixes. Let's illustrate how this works.

Engineering Joint Costs

Assume that a unit of D produces 0.5 lb. X and 0.2 lb. Y. Each unit of D costs $0.10.

This article is based on a paper delivered at the 2nd annual meeting of the American Association of Cost Engineers, held in Cleveland, June 1958.

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H. R. MCENTEE *is engaged primarily in process development, process design and economic evaluation. He has also taught applied mathematics to company classes. An associate member of AIChE, McEntee is a recipient of both BS and MS degrees from the University of Michigan.*

Also, an alternate process exists, in which a unit of B produces 0.1 lb. X and 0.5 lb. Y. Each unit of B costs \$0.15.

If both processes are running, the yields of X and Y will be:

$$X = 0.5D + 0.1B \quad (1)$$

$$Y = 0.2D + 0.5B \quad (2)$$

Now, if we want to operate so as not to have any byproduct, solution of Eqs. (1) and (2) will tell us how many units of D and B to run for various demands of X and Y. Thus:

$$D = \frac{5.0X}{2.3} - \frac{1.0Y}{2.3} \quad (3)$$

$$B = \frac{-2.0X}{2.3} + \frac{5.0Y}{2.3} \quad (4)$$

Obviously, these equations apply only in the region:

$$\frac{2.0X}{5.0} < Y < \frac{5.0X}{1.0}$$

This, of course, is the region of joint rather than byproduct costing.

If we apply unit costs to Eqs. (3) and (4) we find that:

$$C_D = 0.10D = \frac{0.5X}{2.3} - \frac{0.1Y}{2.3} \quad (5)$$

$$C_B = 0.15B = \frac{-0.3X}{2.3} + \frac{0.75Y}{2.3} \quad (6)$$

And since the total cost C_T is the sum of the costs of running D and B:

$$C_T = C_D + C_B = \frac{0.2X}{2.3} + \frac{0.65Y}{2.3} \quad (7)$$

From Eq. (7), we can see that 0.2/2.3 is the *unit cost* of X, and 0.65/2.3 is the *unit cost* of Y. Since our two processes are controlled by Eqs. (3) and (4) to give no excess of X or Y, each additional pound of X will cost us \$0.2/2.3; likewise, each additional pound of Y will cost \$0.65/2.3.

Limitations of Third System

This third system of joint costing is particularly applicable when cost is the significant factor guiding pricing decisions, rather than when pricing guides allocation of costs. The system is also very helpful in clarifying thinking when there are three or more joint products and processes. It is subject to error, however, when there is poor judgment in the selection of relevant processes and their costs.

It is also subject to error when some of the process combinations have a definite capacity limitation. If this is the case, production from the limited unit virtually constitutes a "fixed cost," and costing may be based on the remaining processes. Or, if a process combination is affected, a capacity function may be included in Eqs. (1) and (2). This results in the appearance of a capacity term in Eq. (7). The term must then be reallocated to X and Y.

In a complex case, we should check on the validity of the desired unit costs in ranges of production that are likely, but perhaps beyond the range of the correlation. The preferred way of doing this is to extend Eqs. (1) and (2) to include all relevant inequalities and capacity limitations. Total costs over a wide range of X, Y, . . ., etc. are then computed by linear programming[1,3], and compared with costs predicted by the unit costs derived above. In this way, we can avoid serious pitfalls.

Byproduct Costing Systems

From the standpoint of manufacturing cost control, the only cost of a byproduct that will not confuse production efficiency with byproduct utilization is zero. Nonetheless, we continue to be concerned about byproduct costing for two good reasons.

The first is that some production people in businesses dealing with expensive products wish to detect sloppy handling of anything, byproducts included. As a second reason, there is the risk that byproduct consumption will grow to the point where byproducts really become products. At this point, existing price patterns may be unprofitable.

Costing on the basis of this second criterion involves evaluation of a risk in terms of dollars. This risk cannot, we feel, be properly evaluated on any purely formal basis such as the costing of byproducts identically with the main product, based on total pounds used. Nor should evaluation of risk follow the scheme of costing byproducts in the ratio of sales value to sales value of product, based on total pounds used.

From the engineering standpoint, the first question is: "How would we make more of the byproduct if it became a product?" Frequently, the answer to this question represents a process modification that is cheaper in total cost than our existing process, and is based on our accumulated experience on how not to make our existing product. Joint costing of our byproduct with the existing products, taking into account this process modification, will give us an estimate of *potential* relative cost.

The second question is: "What is the *probability* that this potential cost will apply instead of the current cost of zero? Evaluation of this probability requires judgment of both marketing and new product developments, of course.

Find Byproduct Unit Cost

For a given year, in the absence of marketing information, an estimate of the above-mentioned probability might be:

$$\text{Probability} = \frac{\text{Budgeted consumption}}{\text{Budgeted production}}$$

Or, when inventory is extremely high:

$$\text{Probability} = \frac{\text{Budgeted consumption}}{\text{Budgeted production and inventory}}$$

Our suggested byproduct unit cost C_s, can thus be defined by the equation:

$$C_s = \text{Potential cost} \times \text{Probability}$$

One advantage of this formula is that it converges to the correct joint cost as consumption grows; sudden upsets in the cost system are thus avoided. Another advantage is that the formula maintains a good cost incentive for the guidance of marketing when byproduct consumption is low.

Note, however, that the formula has some disadvantages. It underestimates the profitability of byproduct sales at any point under full consumption. It also requires more work and judgment than any simple approximation. Nevertheless, the formula does result in fuller utilization of engineering judgment in setting byproduct costs.

REFERENCES

1. Charnes, A., W. W. Cooper and A. Henderson, "An Introduction to Linear Programming," John Wiley & Sons, Inc., New York (1953).

2. Nerner, J. J. W., "Cost Accounting," Richard D. Irwin, Inc., Homewood, Illinois (1957).

3. Smith, H. F., "Linear Programming for the 650," International Business Machines Co., Chicago, Illinois.

4. NACA Research Bulletin No. 23, "Direct Costing," April (1953).

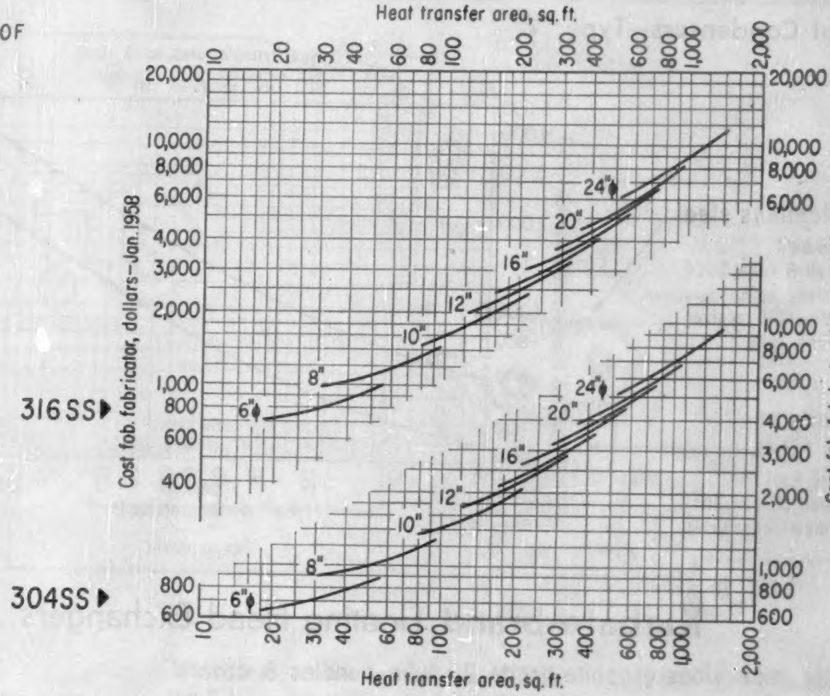
No. 9 Floating Head & Fixed Tube Sheet Heat Exchangers

H. J. De Lamater; Chairman, AACE Heat Exchanger Cost Committee

Doyle & Roth Fixed Tube Sheet Exchangers

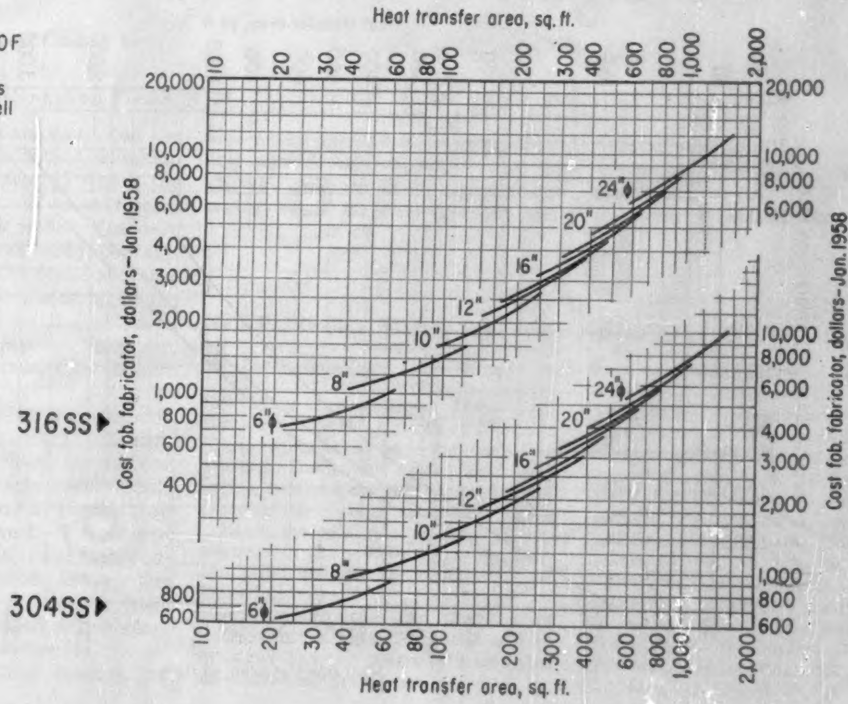
Liquid-to-Liquid—Model "LL"—TEMA Class A

¾" OD x 18 BWG tubes
on 15/16" Δ pitch
75 psi. shell & tube; 400 F
Stainless steel tubes
tube sheets & bonnets
Seamless steel pipe shell



Vapor Condensers—Model "VT"—TEMA Class A

¾" OD x 18 BWG tubes
on 15/16" Δ pitch
75 psi. shell & tube; 400 F
Stainless steel tubes,
tube sheets & bonnets
Seamless steel pipe shell

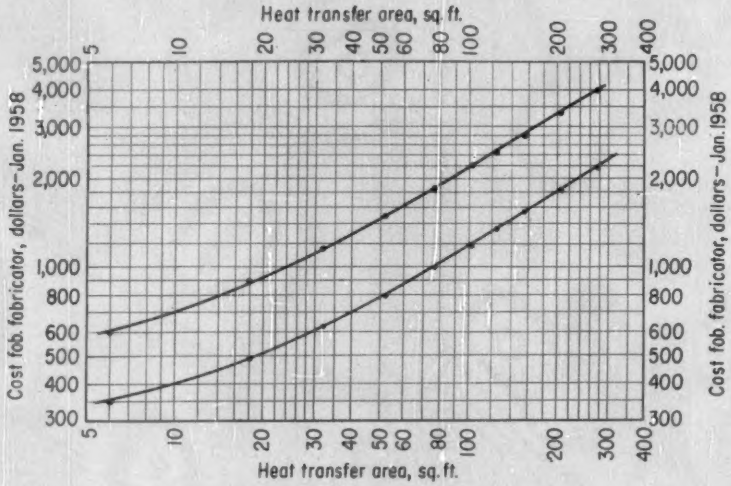


Struthers Wells Fixed Tube Sheet Exchangers

Vertical Condensers—Type "V"

304 Stainless steel
¾" OD x 18 BWG
25 psi. shell & tube; 300F
304 stainless top head, tube sheets & receiver
Carbon steel shell

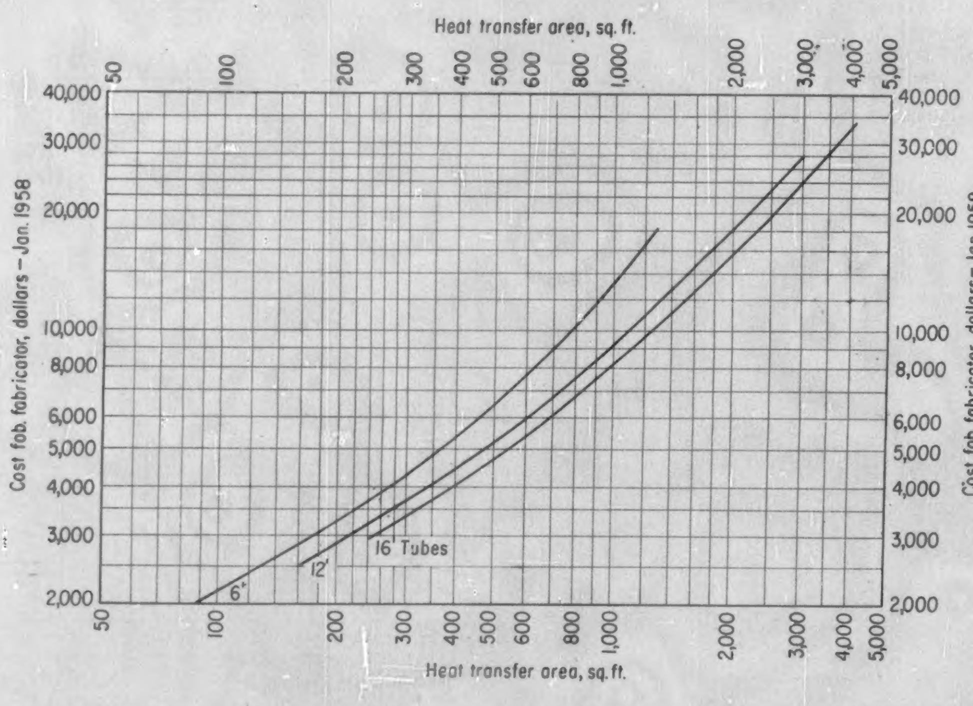
Admiralty or copper tubes
¾" OD x 16 BWG
25 psi. shell & tube; 300F
Carbon steel construction

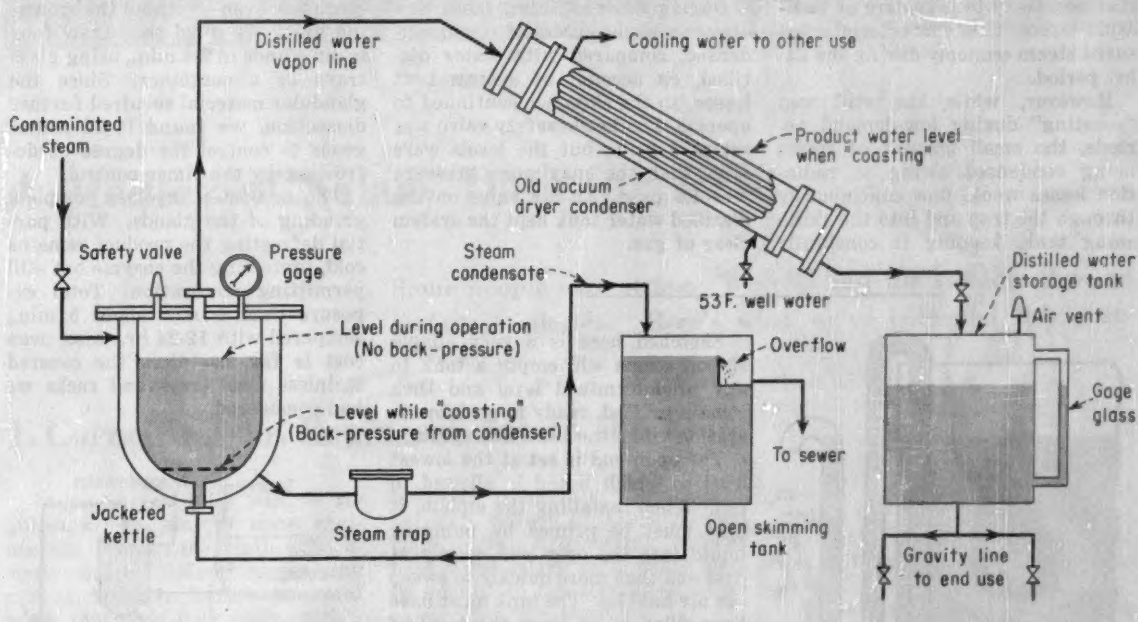


Karbate-brand Floating Head Exchangers

Karbate impervious graphite grade 22 tube bundles & covers

Single pass units
⅞" I D tubes
Steel shell & baffles
Removable tube bundle & full-floating head





Distilled water withdrawal rate controls still back-pressure and hence still water level and amount of water vaporized.

Water-Still Controls Itself Automatically

★ **Winner of October Contest by H. Leslie Bullock**

Engineering Consultant, New York 6, N. Y.

A good many years ago I had the job of providing distilled water to an isolated plant section where the only water supply was an extremely hard and cold well water. The only steam available was badly contaminated. Our need for distilled water was variable throughout a 24-hr. production period so it had to be supplied more or less continuously, but at a variable rate, to a storage tank.

Condensing the stream directly was unsatisfactory owing to its contamination. Therefore, we decided to distill condensate from this steam, after passing it through an open skimming tank. The equipment used, shown in the sketch, consisted of a jacketed kettle, the skimming tank, a steam trap, condenser and distilled water storage tank, plus instruments.

The self-regulating feature of this setup worked as follows: During periods of low water use the storage tank would fill and distilled water would back up into the condenser, masking some of the condenser surface. This in turn would create back pressure which would force water out of the kettle and

NEXT ISSUE: Watch for Announcement of November Winner

★ How Readers Can Win

$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Design Notebook. Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

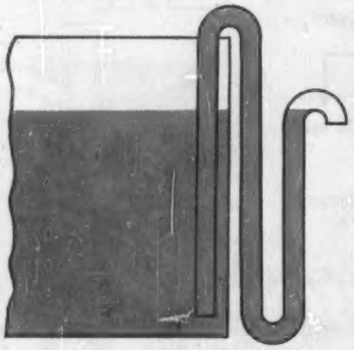
How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable non-winning articles will be published at space rates ($10 min.).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Design Notebooks, *Chemical Engineering*, 330 W. 42nd St., New York 36, N. Y.

into the skimming tank. With little or no water in the kettle, evaporation would substantially cease and steam consumption would drop to that necessary to take care of radiation losses. This characteristic assured steam economy during the 24-hr. period.

However, while the still was "coasting" during low-demand periods, the small amount of steam being condensed owing to radiation losses would flow continuously through the trap and into the skimming tank, keeping it constantly clean and assuring a constant supply of hot water, ready to flow into the distillation kettle at any draw-off of distilled water.

During draw-off, also, there was always a slight excess of steam condensed, compared with water distilled, on account of system heat losses, so the skimmer continued to operate. The kettle safety valve was set at 4 psig., but the levels were such that the maximum pressure was 1.5 psig. An air valve on the distilled water tank kept the system clear of gas.



Simplified Siphon Also Holds Its Prime

C. F. A. Roberts
Superintendent,
Plant Investigations Dept.
Orr's Zinc White Ltd.
Widnes, Lancs., England.

Editor's Note—A recent Plant Notebook prize (Oct. 6, 1958, p. 153) went to Dr. Roberts for a two-speed, never-empty tank siphon which was the most ingenious invention in siphons to come to this editor's attention. Having been notified of his winning, Dr. Roberts wrote: "Your letter prompted me to think the problem through again from first principles—and I suddenly wondered what on earth I'd been playing at to devise so complicated a piece of equipment! In the Mark II siphon, I've greatly simplified the idea. Compared to Mark I, its only disadvantage is that it is somewhat slower for the same diameter of tubing."

When you have the problem of maintaining a tank level between given working limits, a siphon may be a good solution, especially if the tank is glass or rubber-lined.

Sketched here is a very simple siphon which will empty a tank to any predetermined level and then remain primed, ready to go into operation when the tank fills again.

The open end is set at the lowest level to which liquid is allowed to fall. When installing the siphon, it first must be primed by pumping liquid into the open end, slowly at first and then more quickly to sweep out air bubbles. The tank must have been filled to at least the level of the outer end before this can be left open. When any additional liquid is added to the tank, it will overflow until the tank level drops to that of the open end. However, although flow will then cease, the siphon will not break since air cannot get past the bend at the outlet.

Such a siphon can easily be rigged from a piece of hose suitably supported. The siphon's dimensions, of course, will depend on the size of the tank, the working level, and the rate of emptying desired.

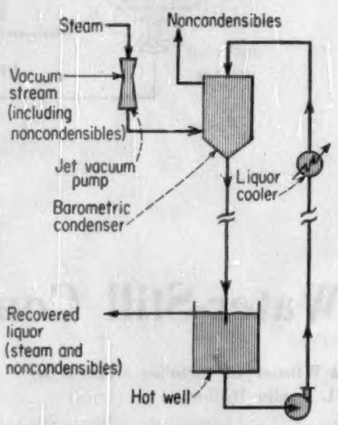
Electronic Oven Defrosts Enzymatic Material

Norman L. Hobbs
Manager of Technical Service
Product Development Laboratory
Wyeth Institute for Medical Research
Philadelphia, Pa.

In one of our processes for extracting enzymatic material from animal glands we have found it necessary to keep the raw material frozen until 12 to 24 hr. before use. Formerly we would spread the frozen glands out on paper to thaw, 300 to 600 lb. at a time, requiring a very large thawing area and introducing the possibility of bacterial contamination or the development by pyrogens.

To overcome these difficulties, we decided to try a domestic model of electronic oven—without the browning unit. We could then thaw four to six glands in 2-4 min., using glass trays as a container. Since the glandular material required further dissection, we found it advtantageous to control the degree of defrosting by the timer control.

The final step involves complete grinding of the glands. With partial defrosting the product remains cold, protecting the enzyme but still permitting maceration. Total exposure time is now about 5 min., compared with 12-24 hr. Also, oven cost is far less than the covered stainless steel trays and racks we had considered.



Avoid Excess Dilution in Recovering Condensates

Jerome A. Seiner
Development Engineer
Paint Research Department
Pittsburgh Plate Glass Co.
Springdale, Pa.

In processes evacuated with steam jet pumps, byproduct materials are often lost due to extreme dilution in the barometric condenser. An example might be hydrochloric acid which normally would be neutralized in the hot well for disposal, thus involving neutralization expense and losing possibly valuable material.

The diagram shows how dilution can be avoided by using no fresh makeup water in the condenser, merely cooling and recycling the condensate.

PRACTICE . . .

YOU & YOUR JOB

EDITED BY R. F. FREMED

A Medley of Salary Data for 1958

Some people save string. We clip and file random data on technical salaries. Here's what we've collected this year.

1. Cornell's 5-Yr. Engineers Are in the Chips

As you know quite well, it requires a 5-yr. stay at some engineering colleges to obtain a bachelor's degree. Most engineering schools, however, have a course of study that lasts four years, with a summer session, or surveying camp or a between-semesters unit operations lab thrown in for good measure.

Does this fifth year of undergraduate work pay off? Or does the 5-yr. undergraduate suffer an economic disadvantage in the long run? Through the courtesy of Dr. C. C. Winding, Director of Cornell University's School of Chemical and Metallurgical Engineering, we now have some salary data which may be applied to the formation of an answer for this question.

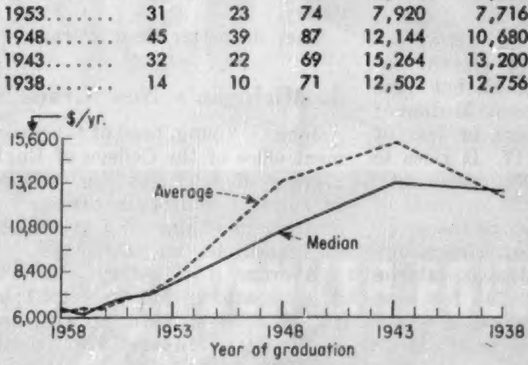
In Table I, below, salary figures are given for chemical engineering graduates of Cornell back through 1938. These men completed a 5-yr. undergraduate course. In addition to the tabulated salaries we have a somewhat more detailed analysis on the 1958 graduating class. Average starting salary was $533/month; median, $535/month. The median for the top half of the class was $552; highest reported salary was $575/month; and lowest was $491.

These figures are for 29 men who supplied information. In a few instances, 1958 grads did not report salary information and a considerable number of the 1958 grads entered the Armed Forces and graduate schools.

When the data are plotted, some points of interest show up. Note that this year's graduates are being

Salaries of Chem. Eng. Graduates—Table I

Class Of	No. In Class	No. Of Replys	%	Avg., $/Yr.	Median, $/Yr.
1958.......	—	29	—	6,396	6,420
1957.......	40	26	65	6,360	6,336
1956.......	33	15	45	6,696	6,756
1955.......	29	14	48	7,204	7,240
1954.......	39	29	74	7,404	7,376
1953.......	31	23	74	7,920	7,716
1948.......	45	39	87	12,144	10,680
1943.......	32	22	69	15,264	13,200
1938.......	14	10	71	12,502	12,756



Breakdown of the Class of 1953—Table II

Major Field	No. Of Reports	Highest Salary, $/Yr.	Avg. $/Yr.,	Median, $/Yr.
Science...........	16	12,500	7,986	8,010
Engineering........	109	10,068	7,057	7,450
Manufacturing......	31	12,000	7,303	7,300
Labor Relations....	10	8,400	7,017	7,175
Sales............	47	12,000	6,925	6,780
Military Service....	12	8,460	6,780	6,750
Utilities...........	9	8,628	6,696	6,600
Hotel and Restaurant	15	11,000	7,061	6,410
Insurance..........	11	10,360	5,392	6,400
Advertising, Public Rel. and Publishing	15	8,400	5,980	6,000
Federal Govt......	7	6,900	5,784	5,980
Teaching..........	17	9,600	5,697	5,800
Banking and Finance	21	10,000	5,280	5,580
Agriculture........	26	20,000	6,492	5,465
Law.............	25	8,300	5,205	5,250
Medicine.........	24	8,000	2,825	2,350

NOTE—Survey by the Cornell University Placement Service in July, 1958 to determine what careers graduates pursue and what progress they make. Of 1,400 questionnaires sent, 588 were returned (over 40%). However, this group may not represent the class as a whole.

hired in at rates that are more than those being paid to men who have been out of school for a year. What a salary administration headache this can cause.

Once again we see the plateau effect on salaries as people stay in the profession past the 10- or 15-yr. mark. And if you stay in engineering for as long as 20 years, your younger colleagues may be earning more than you.

Comparing the Cornell survey with other salary surveys is difficult because of the small number of salaries reported and because the data were supplied by employees rather than employers. Usually, employee surveys show higher salary curves because the missing replies belong to those who are ashamed of their salaries. The most successful and highest paid people are the first to respond.

In any event, this survey shows us that chemical engineers after completing five years at Cornell are doing quite well. They start high and show fast progress in earning power.

In Table II we've shown the results of a survey conducted by the Cornell University Placement Service on the Class of 1953. Mr. David M. Kopko, Asst. Director of the service agreed reluctantly to allow us to reproduce this information because he was dissatisfied with the number of returns. Of the 1,400 questionnaires sent, only 556 were returned in time to be included in the statistics. Because of this, Kopko suggests that the survey may not represent the entire class.

Our chemical engineers (comparing Tables I and II) seem to be doing better than the engineering graduates as a group. The only median salary that is higher than engineering is that reported for science graduates. However, most of the 16 scientists who replied must be outstanding individuals. Notice the guy who after only 5 years is earning $12,500/yr. Farming may not be such a bad racket, if you have connections. The reported income of $20,000 is very appealing. But the doctors of medicine take it on the chin (or in the wallet, if you prefer). After five years they are still struggling to earn enough to live on, reporting a median income of only $2,350/yr.

Chemical engineering at Cornell does pay, even if it takes 5 years to get a B. S. degree.

2. Ceramic Engineers

The National Institute of Ceramic Engineers has just completed a salary survey of all members of their national society and the parent organization, the American Ceramic Society.

Tabulated below are the median incomes reported by members of the American Ceramic Society arranged by the number of years since receiving the bachelor's degree:

No. of Years	Median Annual Income, $
0–4	6,200
5–9	8,000
10–14	9,000
15–19	10,800
20–24	11,900
25–29	12,600
30–34	13,000
35–39	14,000
40 or more	14,000

Median salary for all members of the society is $10,000 compared to $8,000 in 1953. Median salary for the ceramic engineers as a group is $12,000 in 1958 compared to $8,800 in 1953.

Apparently a ceramic engineer is to a ceramist what a chemical engineer is to a chemist.

3. Experimental Biology

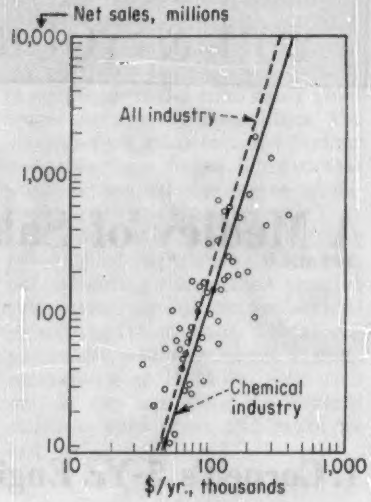
If only I could have seen clearly through a microscope, I might have majored in biology instead of chemistry in high school. Does this apply to you also? If so, you'll be interested in the survey completed this past summer by the Federation of American Societies for Experimental Biology.

Survey was made on 9,237 experimental biologists who returned questionnaires. Of these 58% hold Ph. D. degrees, 33% M. D. degrees and 9% had at least two doctoral degrees.

Median 1958 salary for the entire group was $8,405 but rose steadily with experience. Median of those with four years or less of experience was $6,117. It rises to $11,774 for the 1,000 experimental biologists with 28 yrs. or more of professional work behind them.

As in other fields of science, universities pay the lowest salaries with a spread of $2,244 for newcomers in the profession to $8,000 for those who have practiced 28 yrs. or more.

Total Compensation of Chief Executives



4. Top Brass Pay

Indirectly, your salary is fixed by the amount of money that the president of your company earns. For example, if the president of a large corporation earns $100,000/yr., then the vice president may get to the $50,000/yr. level.

That would put the chief engineer at about $35,000 and all other engineering salaries would be scaled down from there. Therefore, you ought to be extremely interested in the total compensation paid to the top man in your organization.

Harvard Business Review conducts such a survey each year. They correlate total compensation of the chief executive as a function of the net sales of the business. Since the latest sales figures are to the end of 1957 only, this 1958 survey reports 1957 salaries. The chart above shows how chemical industry top executives compare with all of industry.

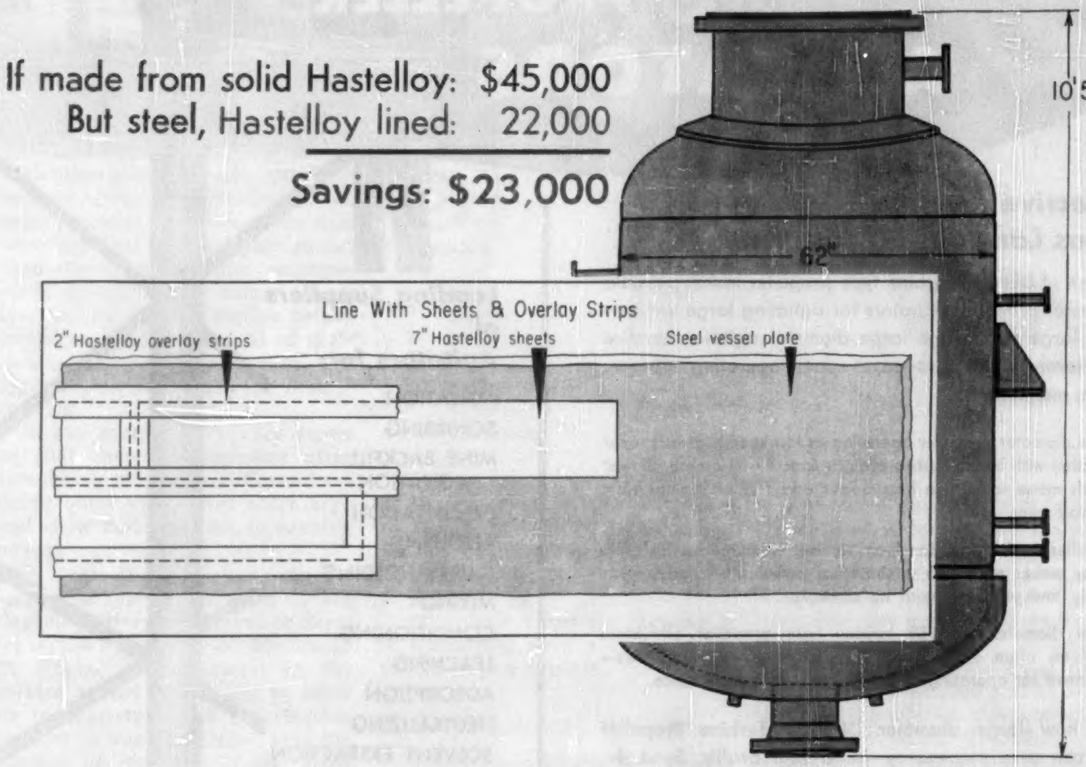
They do better than average.

5. Michigan's New Grads

John G. Young, head of the placement office of the College of Engineering at Michigan reports that in spite of a drop in campus recruiting of engineering graduates, all found jobs this year.

Average B. S. salary offer was $480/month, up $15 from 1957; at the M. S. level, $570, up $18; and at the Doctorate level, $732/month, up $52.

CORROSION FORUM EDITED BY R. B. NORDEN



Lining Technique Halves Vessel Cost

Consider lining with hard-to-fabricate Hastelloy. Large vessels can be lined by welding; are much cheaper than solid-alloy equipment.

J. F. De Lorenzo, Manning & Lewis Engineering Co., Newark, N. J.

For corrosive service, it's surprising that alloy-metal-lined equipment is not called for more often in chemical and petroleum plant designs.

Such equipment will usually perform as well as solid alloy vessels. And a lined tank or reactor is much lower in cost, particularly if the alloy is expensive and difficult to fabricate.

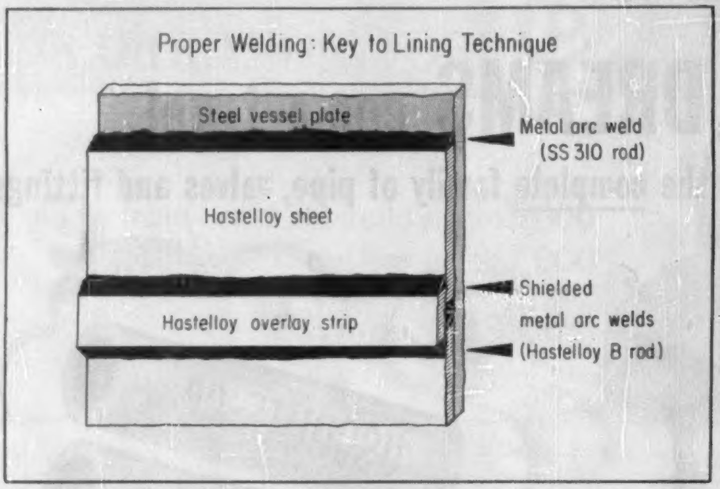
▶ **Big Lining Job**—For example, we have just completed one of the largest lining jobs yet done with Hastelloy alloy B. The 10-ft. 5-in. high by 5-ft. 2-in. O.D. (carbon-steel shell) pressure reactor (*above*) cost $22,000 before installation. A solid-alloy vessel would have cost around $45,000.*

Of course certain precautions have to be taken when applying the lining—which involves welding liner strips to the carbon steel vessel, sealing seams and welding overlay strips. But this technique avoids all the difficult problems of machining and forming high-cost Hastelloy B.

Still another approach would have been used of integrally-clad metal. This process for Hastelloy B is still under development, although such a cladding has been used successfully in heads and shells. Cost of a clad vessel would have been approximately halfway between our lined vessel and one made from solid alloy.

The final lined vessel (all inlet and outlet openings were also lined) is in use at the Atzcapotzalco petroleum refinery in Mexico. It is a pressure reactor for an isomerization unit, handling boiling HCl. Design adhered to the ASME

* Estimated cost of a solid carbon-steel vessel: $6,000.



Boiler and Pressure Vessel Code, section VIII, for corrosive service at 350 psi. and 450 F.

▶ **How It's Done**—Preliminary steps in the construction process involve cutting to size and forming all carbon steel parts. The lining material (nickel 61%, molybdenum 26 to 30%, iron 4 to 7%, cobalt 2.50%, chromium 1.00%, manganese 1.00%, silicon 1.00% and carbon 0.05%), was also cut into plates and formed whenever this could be done preceding actual fabrication. Our technique called for lining the shell section with 8 courses of $\frac{3}{16}$-in. thick by 7-in. wide Hastelloy B sheet. Each course contains 4 pieces, 7-in. wide by 46$\frac{3}{4}$-in. long, put in transversely one at a time.

J. F. DeLorenzo received his BS degree in mechanical engineering from Louisiana State Univ. in 1943, and has done graduate work at Columbia in N. Y. Following military service from 1943 to 1946 in the Corps of Engineers, U.S. Army, he joined the design engineering staff of Manning & Lewis Engineering Co., Newark, N. J. His experience there has included all phases of design and estimating of heat exchangers and pressure vessels used by the petroleum and chemical process industries. In 1953 Mr. DeLorenzo was named Chief Engineer of Manning & Lewis.

Prior to welding each liner piece, we sandblasted the shell area to be covered.

Strips were kept tightly against the shell with a hydraulic jack and a hard wood form. This helped to dissipate heat generated by welding. No preheating was used because the alloy is hot-short at elevated temperatures.

Welding was done by the metal-arc process in the downhand position with coated stainless steel 310 electrodes for the carbon steel to alloy welds. Normal current, for the $\frac{3}{16}$ in. electrode, is 90 amp. at 25 volts. To keep heat effect on the alloy to a minimum, we directed the electrode almost entirely on the steel with the edge of the arc making contact with the liner. A single bead was used and laid in at the most constant speed possible for non-automatic welding. To avoid locked-in stresses, we welded one short and one long edge of the liner and allowed this to cool before welding the other two edges.

▶ **Head More Complicated**—Understandably, the procedure for lining the elliptical head is more complicated. Positioned concave side up, the elliptical head was surmounted by a pipe tripod, with tripod legs clamped to the straight flange. The apex served as the pivot point for the hydraulic jack that exerted pressure on the hard-wood forms used to position and form liner pieces. Welding technique: identical to that used on the shell.

Spaces between adjacent liner sections were covered by 2-in. wide strips of 14-gage Hastelloy B—welded to the alloy lining using the inert-gas metal arc-welding process, with $\frac{1}{16}$-in. diameter bare wire as filler metal. Channels under the overlay strips are continuous throughout the vessel to permit testing of the overlays for leakage.

▶ **To Be Sure**—Testing of the vessel's lining called for introducing pressure behind the overlay strips.

Weep holes ($\frac{1}{16}$-in. diameter) were drilled behind all pieces of overlay stripping, with a similar hole drilled behind each piece of liner plate. Pipe couplings were then welded over each weep hole. Air at 15 psig. came in through an overlay strip weep hole at one end of the vessel. We checked all other weep holes under the overlay strips for air flow and then plugged. This procedure made certain air was flowing through the space under all overlay strips.

With all weep holes plugged, inside seams were then checked for leakage by preliminary soap and water tests, followed by highly sensitive tests using Freon and a halogen leak detector. These showed all seams free from leakage. Plugs were removed and an internal halogen test performed with all external seams and weep holes probed.

After removing the couplings, weep holes in the bottom head were plug welded. And after installing the bottom head jacket, entire unit was subjected to final hydrostatic testing (525 psig. in the shell and 115 psig. in the jacket).

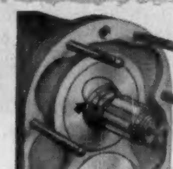
Cooling-Tower Problem Licked

A modified epoxy coating, designed to protect wood cooling towers, is causing quite a stir among design engineers.

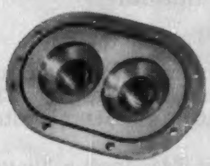
The developer—A. R. Moberg Laboratories, Inc., Los Angeles, Calif. — claims their coating* provides a means for prolonging the life of cooling towers indefinitely. It eliminates problems of wood delignification, chlorine attack, white and brown dry rot.

Up to now the best available

* Permaclad Towercote



SLOT AND PIN DEVICE keeps stainless steel sleeve and shaft rotating together, saves greatly in shaft wear. Sleeve is reversible for longer use.



REUSABLE RUBBER PUMP HEAD GASKET provides a positive seal.

NEW OPTIONAL SIDE MOUNTING DESIGN reduces number of fittings, makes heavy, viscous fluids easy to pump.

SHORT DISTANCE BETWEEN FRONT AND REAR BEARINGS contributes to long life, allows operation against pressures up to 150 PSI.

THE WAUKESHA VENTED COVER PUMP permits variable volume with constant speed. Provides internal relief valve.

Stated in capsule form — when you equip your plant with WAUKESHA PUMPS you can be tranquil about pumping problems. WAUKESHA PUMPS live long trouble-free lives — for they are engineered and BUILT with great reserves in ruggedness and operation in excess of usual pump design. Check the features shown here. They tell the story.

And WAUKESHA PUMPS "tranquilize" your product flow. No turbulence. No product breakdown. No noticeable pulsation. Heavy, viscous fluids, products with large, discrete particles are no more a problem than products of low specific gravity. Get tranquility now with WAUKESHA.

Waukesha
FOUNDRY COMPANY
DEPT. U-12, WAUKESHA, WISCONSIN

technique for controlling these effects was by maintaining a proper pH in the cooling water. This was never completely satisfactory.

Fluor Products Co., Whittier, Calif., has exclusive rights to apply the coating in the field. Also, Fluor will coat wood on all their new cooling towers before erection.

One big advantage: special resins and catalysts permit use of the epoxy coating on wet or dry wood surfaces. This claim is backed up by extensive laboratory testing. So it's not necessary to take a tower completely out of service before applying the coating.

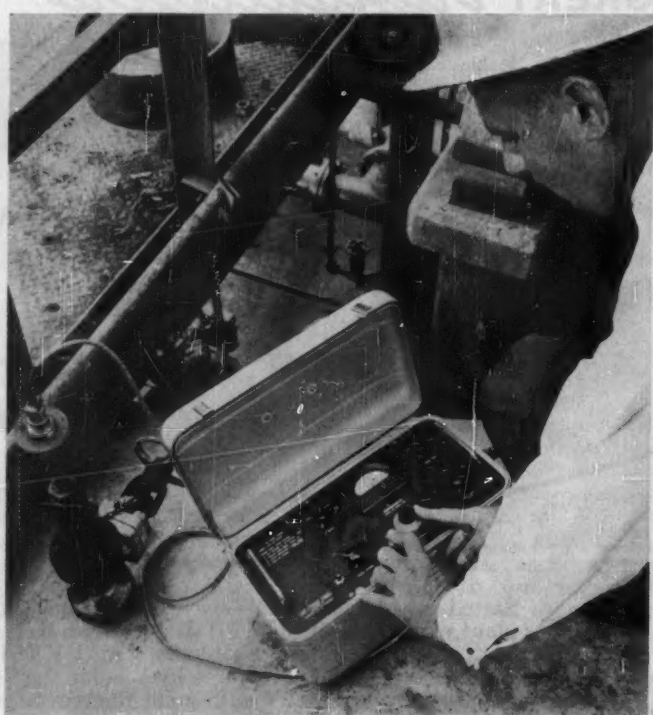
Present planning calls for a two mil coat on new tower units. Fluor will do this on a production-line basis, then ship the components to the jobsite for erection. The outside tower sheathing could also be sprayed to prevent any leakage or seepage. A two mil coat appears sufficient for 10 to 15 years protection.

For existing towers the coating would be applied one cell at a time to minimize down time. A full tower coating could be completed in one to three days.

Procedure would go something like this: the first cell to be coated would be taken off stream, hosed down, and allowed to drip and dry from one to three hours. Then components would be spray coated. A second coat, if required can be put on one hour after the first. The cell would be back on stream four to five hours after the initial coat. But the resin will continue to cure under water.

In addition to the advantages mentioned, there are some other good points:

- Coating will cost about the same as pressure impregnating pretreated wood with a germicidal material, while giving better protection.
- Coating is fire retardant.
- There is no loss in wood strength.
- It does not leach or dissolve in water.
- Coated wood allows much wider latitude in chemically treating circulating water. Water treatment can now be designed to control corrosion in the heat exchange equipment. Previously some compromise had to be reached since wood deterioration limits the choice of inhibitors.



Crest Instrument Co.

Corrosion Meters: Quick Way to Optimum Inhibitor

Since their introduction (Chem. Eng., Jan. 1957, p. 156) corrosion meters have rapidly moved into chemical and petroleum plants, where the portable models are particularly useful in field testing.

Inhibitor evaluation is one area where the meters are proving their worth. Here they quickly establish optimum inhibitor concentrations under actual process conditions. Previously metal coupons would be suspended in the process stream, removed periodically and checked for weight loss. This is a long, drawn-out procedure.

The meter measures electric resistance of two probes, one exposed to the corrodent, the other protected by plastic or ceramic; gives a quick reading without removing the probes.

Now: Tantalum-Lined Equipment

Another example of an unusual lining job comes from The Pfaudler Co. and Haynes Stellite.

Pfaudler has lined a 30 gal. vessel with 0.030-in. thick tantalum sheet. Two recent developments make this possible: availability of large tantalum sheets and improved Ta welding characteristics (Haynes Stellite has done a lot of work in this area).

Welding was done inside a special chamber filled with inert gas.

The vessel's base metal is Type 430 stainless. It also has a solid tantalum agitator; is designed for 650 F., 500 psi.

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USS National PVC Pipe tames unruly chemicals and gives maintenance-free performance

USS National Polyvinyl Chloride Pipe resists chemical corrosion, does not permit build-up of internal deposits, cleans easily, installs easily, and has a low initial cost. What's more, National PVC Pipe *does not contaminate* sensitive solutions.

USS National Polyvinyl Chloride Pipe has a variety of uses in the chemical industry, because it handles acids, alkalies, salt solutions and alcohols with the same impunity with which it transports water.

Two types of USS National PVC Pipe are available:

Normal Impact—for installations requiring the highest chemical resistance attainable, together with high strength and excellent creep resistance.

High Impact—for installations requiring excellent chemical resistance and a high degree of toughness, even at low temperatures.

USS National PVC Pipe comes in sizes from ½ inch to 14 inches in diameter, and in Schedules A, 40, 80 and 120.

If you'd like more information, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa. Ask for Bulletin No. 24.

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United States Steel Export Company, New York

In financial aid to education...

What Should Business Do Now?

Now that the federal government is entering the field, should business firms stop giving financial aid to our colleges and universities?

This question is now being discussed by business directors throughout the country. The discussion is prompted by the near-billion-dollar program of federal aid to education passed by Congress a few months ago. For if the federal government, with its access to billions in taxes, is assuming responsibility for the financial welfare of education, should not business get out of the way and let the government take over? This is the general way the question is being asked.

The answer is a resounding NO.

What The Federal Program Does

The new federal program makes it possible for the government to spend the imposing total of $900 million for aid to education over the next four years. There are still many loose ends in the program. But already it's quite clear what such funds will — and will not — do to help relieve the financial plight of our colleges and universities.

First of all, the program is not going to solve any financial problems in education overnight. The program is just barely underway. So far no money has actually been allocated, and Congress has appropriated only $40 million — less than 5% of the total.

More important, there is very little in the total program which will result in direct aid to colleges and universities. The program does set up fellowships to train college teachers. But most of the aid will eventually be channeled through the states to primary and secondary schools. The main focus of the program is education for national defense — strengthening science, mathematics and foreign languages in elementary and secondary schools, together with grants for counseling, testing and research.

The one big item for higher education is a $295 million student loan program, which will help needy students pay tuition and other fees. But tuition rarely covers the full cost to the college of educating a student. So the net result could well be an additional financial strain on our institutions of higher learning.

For the three most pressing financial needs — faculty salaries, scholarship grants and new plant and equipment—colleges and universities must still rely heavily on help from the business community. And it would indeed be a major

misfortune if the recent actions of the government put a blight on this growing and substantial support to higher education.

In the last ten years, business has expanded its financial aid to education by more than four fold. In 1948, contributions were only $24 million. In 1957, such aid reached an estimated $125 million. Moreover, corporations have been putting a larger proportion of their total charitable gifts into education. In 1950, the percentage was only 17%. By pre-Sputnik 1956, the share had already increased to 34%, according to figures recently released by the Council for Financial Aid to Education.

Why Business Must Help

The most compelling reason for increasing business aid to higher education — at an even faster rate—is that our colleges and universities desperately need financial help. It is that simple. Private contributions to higher education must average at least $400 million over the next ten years if our colleges are to meet rising operating costs and raise faculty salaries to decent levels. Despite the growth in business contributions, we are still well below that goal.

If our colleges cannot solve their mounting financial difficulties through voluntary help from business firms, alumni and communities — then it is to be expected that federal aid ultimately will be mobilized in a big way. In principle, if not in dollars, the 85th Congress has paved the way. Indeed, a large federal scholarship program was squeezed out of this year's legislation only in the course of last-minute compromises. And Arthur S. Flemming, Secretary of Health, Education and Welfare, has urged that the next session of Congress restore the scholarship program.

About any federal rescue operation for higher education, two things are quite clear:

(1) **Such aid will come too late to prevent irreparable harm resulting from the current shortage of funds.** The need for help is urgent and immediate.

(2) **With federal taxes taking over half of all corporate income, any federal program in the end will be financed in large part by the business community.**

An Opportunity

So, viewed narrowly, it is in the selfish interest of business firms to aid our colleges and universities now, rather than wait and be forced to pay later on. By doing so, they ensure that business will have a continuing supply of well-trained graduates. They take advantage of the tax laws for charitable contributions which mean the government in effect assumes more than half the cost of business aid to education. And they win gratitude for a voluntary and generous act.

Viewed in the broad public interest, the business community has an opportunity to perform a financial rescue mission in education which could well be the key to successful survival, not only of our present system of higher education, but also of the nation itself.

As previous editorials in this series have pointed out, a very small share of the net income of business firms — about 1% — would do the job. Certainly business must not be distracted from this opportunity by the new venture of the federal government in financial aid to education.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

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Editor-in-Chief

In August 1946 *Chemical & Metallurgical Engineering* was renamed *Chemical Engineering*. *Chemical & Metallurgical Engineering* was the successor to *Metallurgical & Chemical Engineering*, which, in turn, was a consolidation of *Electrochemical & Metallurgical Industry* and *Iron & Steel Magazine*. The magazine was originally founded as *Electrochemical Industry*.

McGRAW-HILL PUBLISHING COMPANY, INC., NEW YORK CITY

Volume 65

January to December 1958

GENERAL ALPHABETICAL INDEX

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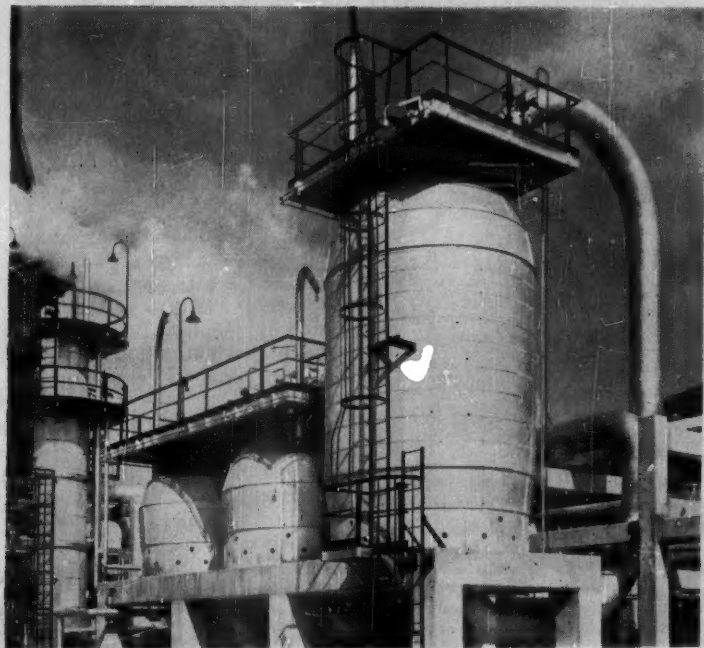
FIRMS IN THE NEWS

R. A. LABINE

NEW FACILITIES



More Heavy Artillery for the High-Octane Battle

Three catalytic reactors above are part of a new high-severity Houdriforming unit at Tidewater Oil's Avon, Calif., refinery. Unit upgrades nearly 1 million gal./day naphthas into high-octane blending stock; reactors were fabricated by Chicago Bridge & Iron Co.

Mobay Chemical has upped manufacturing capacity for toluene diisocyanate chemicals by 50% at its Martinsville, W. Va., plant. Expansion is intended to keep pace with the rapidly growing urethane products industry. Firm also says that it is working on a new "one-shot" foaming process that will greatly simplify production of commercial urethane foam slabs.

HEF, Inc., jointly owned by Hooker Chemical and Foote Mineral, is finishing up construction on its new 4-million-lb.-yr. ammonium perchlorate plant near Columbus, Miss. Tune-up will start in mid-January with full-scale production scheduled to get under way in February. Jointly-developed process can also turn out lithium perchlorate if missile program changes over to that oxidizer.

Coastal Chemical's $2-million phosphate fertilizer plant at Pascagoula, Miss., is going on stream. Plant, first in U. S. to use St. Gobain's single-stage digestion process, has 75-ton/day phosphoric acid unit and 350-ton/day granulated ammonium phosphate unit under a single roof. St. Gobain process is claimed to be more compact and economical than older multistage processes. Fluor Corp. handled construction.

Allied Chemical's Barrett Div. plans to build a gypsum cal-

FIRMS . . .

cining plant adjacent to its gypsum board manufacturing facility at Edgewater, N. J. Fully automated unit will process gypsum rock direct from ships bringing ore from Nova Scotia.

Dixon Chemical is drawing up plans for a sulfuric acid plant to be erected at Paulsboro, N. J. Plant is being financed by sale of $5.9 million of 6% debentures and 236,000 shares of common stock.

Texaco's 45,000-bbl./day refinery at Anacortes, Wash., is now on stream; catalytic cracker was the last unit to be started up. Refinery will employ a total of 310 workers when up to full capacity.

Olin Mathieson is building an integrated laboratory and pilot plant facility at New Haven, Conn., for metallurgical and nuclear fuel research. Facility, to cost approximately $4 million, will be completed in mid-1959.

Crown Zellerbach Corp. announces that it intends to develop a "large manufacturing complex" in Louisiana as part of a long-term program to keep abreast of the southern pulp and paper industry. When CZ's new paper mill at Baton Rouge comes on stream next year, firm's total investment in Louisiana will be $40 million.

Polymer Industries, subsidiary of Phillip Morris, is about to start an expansion program that will double manufacturing and laboratory facilities at Springdale, Conn. Firm's main products are adhesives used in making foil and other industrial laminates.

Johns-Manville has opened a new plant on Chicago's South Side to make its Dutch Brand line of pressure-sensitive tapes, adhesives and related products. Plant features a unique "combining machine" that continuously laminates strands of organic or synthetic materials on flexible sheeting.

CALENDAR

American Institute of Chemical Engineers, North Jersey Section, Topic: Oil and Chemicals from Sasol Process, Shulton Lab.
Jan. 6 Clifton, N. J.

American Society for Engineering Education, Cooperative Education Midwinter Meeting, Del Prado Hotel.
Jan. 8-9 Chicago, Ill.

Society of Chemical Industry, Perkin-Medal Dinner, Waldorf-Astoria Hotel.
Jan. 9 New York. N. Y.

Lehigh Valley Chemical Engineers Club, Topic: Process Instrumentation, Lehigh University.
Jan. 19 Bethlehem, Pa.

Spectroscopy Society of Pittsburgh, monthly meeting, Mellon Institute of Industrial Research.
Jan. 21 Pittsburgh, Pa.

American Society of Lubrication Engineers, Symposium: Lubricants for Gears, Morrison Hotel.
Jan. 25-27 Chicago, Ill.

Plant Maintenance & Engineering Show, Public Auditorium.
Jan. 26-29 New York, N. Y.

American Society for Engineering Education, Mid-winter meeting, University of Houston.
Jan. 26-27 Houston, Texas

Canadian Pulp and Paper Assn., Technical Division, annual meeting, Queen Elizabeth Hotel.
Jan. 26-30 Montreal, P. Q.

Society of Plastic Engineers, annual technical conference, Commodore Hotel.
Jan. 27-30 New York, N. Y.

First International Symposium on Nuclear Fuel Elements, jointly sponsored by Columbia University and Sylvania-Corning Nuclear Corp., Columbia University.
Jan. 28-29 New York, N. Y.

American Physical Society, annual meeting, New Yorker Hotel.
Jan. 28-31 New York, N. Y.

Society of Plastics Industry, Reinforced Plastics Division, annual technical and management conference, Edgewater Beach Hotel.
Feb. 3-5 Chicago, Ill.

Missouri Petroleum Association, annual convention, Hotel Muehlebach.
Feb. 9-11 Kansas City, Mo.

American Institute of Mechanical Engineers, annual meeting, St. Francis Hotel, Sheraton-Palace Hotel, and Sir Francis Drake.
Feb. 15-19 San Francisco, Calif.

Lehigh Valley Chemical Engineers Club, Topic: Radioactive Tracers in Process Control, Lehigh University.
Feb. 16 Bethlehem, Pa.

Chemical Market Research Assn., Topic: Chemicals for the Textile Industry, Dinkler Plaza Hotel.
Feb. 18-19 . Atlanta, Ga

NEW EQUIPMENT . . .

(Continued from p. 40)

Automatic Xerography

New system for reproducing engineering drawings.

Xerography itself is not new. As a means of reproducing drawings and photographs onto dry, unsensitized paper, it had its start several years ago. But now, for the first time, a xerographic device called a Copyflo 24 makes it possible to complete a unitized microfilm system that quickly, accurately and inexpensively reproduces engineering drawings on a high-volume basis.

The entire system has several component parts, made by several manufacturers. Here's how the system works: Microfilm of original drawings are machine-mounted in data-processing cards. When prints are required, other machines sort and collect the proper cards, which are then fed to the Copyflo 24. This turns out the dry black-and-white prints at a rate of 20 ft./min. Maximum print width is 24 in.

Such a unitized system saves space, time, labor and materials. One company using the system cut drawing service time from 71 hr. to 16 hr. Another company lowered its drawing-reproduction staff from 43 to 23. Space savings run about 70-95%. Over-all, one of the firms expects to save $360,000 annually.

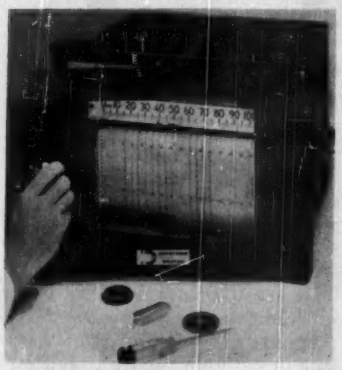
Operation of Copyflo 24 is as follows: A beam of light scanning card-mounted microfilms projects onto a selenium-coated rotating drum, thus sensitizing it's surface. As the drum rotates to a new position, sensi-

tized areas pick up an electrical charge.

At another station, black powder of undisclosed composition, which is applied to the drum's surface, adheres to the charged areas. Further drum rotation deposits the powder on a continuous roll of unsensitized paper. Heat from glowing filaments bonds powder to paper.

Finally, the drum is cleaned prior to its next revolution, and a new microfilm-bearing card replaces the first one. Used cards are rejected for return to filing machines.

Haloid is now working on a smaller printer, the Copyflo 1824, which is not automatic. This unit will be most attractive for smaller-volume operations. — **Haloid Xerox Inc., Rochester, N. Y.** **100A**



Multipoint Recorder

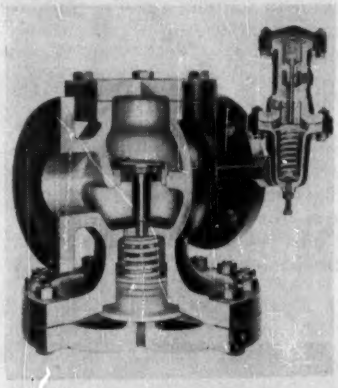
Plug-in adapters provide instrument flexibility.

Chief feature of the new Model 6702 multipoint recording potentiometer is flexibility of application—this single instrument can handle a variety of recording jobs without expensive refitting. For example, if the unit is in service monitoring six points, and additional work load requires scrutiny of 12 points, the operator can adapt the Model 6702 to the new requirements in just 3 min. He merely changes a plug-in unit, and replaces a dial indicator and print wheel.

Range changing requires the insertion of a proper range clip. Adaptation to newly installed transducers necessitates re-

placement of the cold-junction terminal blocks. And for single point recording, a kit converts the instrument into a pen-dragging unit.

Model 6702 mounts in a standard 19-in. relay rack; it is also available for panel or wall mounting. Instrument accuracy is ¼%. — **Weston Instruments, Newark, N. J.** **101A**



Pressure Regulator

For steam service. Has external pilot valve.

Capable of handling maximum pressures of 125 or 250 psi., Type 471 external-pilot steam pressure regulators come in 11 body sizes from ½ to 6 in. The manufacturer claims that, in addition to accurate, fast-response regulation, the new line is suitable for tight shutoff service. A single-seat valve arrangement incorporating stainless steel valve disks and seat rings assures the positive seal in a shutoff position.

Another feature is accessibility. Installation of the pilot valve in a remote location permits quick pressure adjustments even though cramped quarters or obstacles block access to the main valve.

Type 471 regulators are designed for easy maintenance and trouble-free operation. Blind flanges on both the main valve and pilot simplify regulator teardown for inspection and cleaning. Packless construction eliminates binding problems. And, a built-in strainer protects the pilot valve. —**Kieley & Mueller, Inc., Middletown, N. Y.** **102A**

BRIEFS

Annunciator intended for use in locations where only one or a few alarms are required, is a completely self-contained unit built around static switching circuits. Easy to install and inspect, the new unit operates on 24 to 250 v., a.c. or d.c.—**Scam Instrument Corp., Chicago, Ill.** 103A

Analyzer for trace oxygen possesses greater accuracy, sensitivity and stability than other commercially available instruments, according to the manufacturer. Utilizing an electrochemical-cell detecting system, the unit will measure from 0-10 ppm. to 0-1% oxygen with full-scale accuracy of about ±2%.—**Analytic Systems Co., Pasadena, Calif.** 103B

Equipment Cost Indexes . . .

	June 1958	Sept. 1958
Industry		
Avg. of all	230.7	230.9
Process Industries		
Cement mfg.	222.2	223.3
Chemical	231.7	232.3
Clay products	216.0	217.0
Glass mfg.	218.8	219.3
Paint mfg.	223.1	222.8
Paper mfg.	223.3	223.8
Petroleum Ind.	227.9	227.5
Rubber ind.	230.7	230.3
Process ind. avg.	228.2	228.6
Related Industries		
Elec. power equip.	234.3	236.0
Mining, milling	233.1	233.7
Refrigeration	260.7	260.3
Steam power	218.4	218.1

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different Industries. See Chem. Eng., Nov. 1947, pp. 125—6 for method of obtaining index numbers; Feb. 24, 1958, pp. 143-4 for annual averages since 1913.

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PEOPLE . . .

TECHNICAL BOOKSHELF

J. B. BACON

For Two Audiences

FUNDAMENTALS OF HIGH POLYMERS. By O. A. Battista. Reinhold Publishing Corp., New York, N. Y. 140 pages. $5.50.

PHYSICAL CHEMISTRY OF HIGH POLYMERS. By Maurice L. Huggins. John Wiley & Sons, Inc., New York, N. Y. 175 pages. $6.50.

Reviewed by F. C. Nachod, Sterling-Winthrop Research Laboratories, Rensselaer, N. Y.

These small texts on the properties of high polymers have appeared almost simultaneously.

One written by Dr. Battista of American Viscose Corp. is essentially descriptive in nature and will serve as a quick and rapid introduction to the neophyte who has no prior knowledge of polymer chemistry.

The other, written by Dr. Huggins of Eastman Kodak is more sophisticated and is strongly mathematically oriented, covering the fundamentals of thermodynamics and kinetics of formation as well as such properties as elasticity, crystallinity and molecular weight determination.

From the foregoing remarks two types of audiences are outlined who will benefit by one or the other text. As an incidental observation, it might be pointed out that both books are authored by industrial men, and are indeed excellent examples that many fine texts no longer originate solely on the campus of a university but in the research laboratories of progressive and far-sighted commercial enterprises.

BRIEFLY NOTED

DISTILLATION LITERATURE INDEX AND ABSTRACTS. 1946-1952—595 *pp.*, $25; 1953-1954—412 *pp.*, $12.50; VAPOR-LIQUID EQUILIBRIUM, AZEOTROPES, EXTRACTIVE DISTILLATION. 1946-1954—155 *pp.*, $5. CALCULATIONS AND THEORY. 1946-1954—125 *pp.*, $4. *By Arthur and Elizabeth Ross. Applied Science Laboratories, Inc., 140 N. Barnard St., State College, Pa.* Includes abstracts of journal papers, meeting papers, patents and books.

ELECTRONIC PROCESS CONTROL SYSTEMS. 16 *pp. Control Engineering, 330 W. 42 St., New York 36, N. Y.* 40¢. Reprint of special report in Nov., 1958, *Control Engineering* covers fundamentals, what's available in electronic control systems and electrically signaled actuators.

EVALUATED WEATHER DATA FOR COOLING-EQUIPMENT DESIGN. 88 *pp. Floor Products Co., Dept. DEW, Whittier, Calif.* $35. Evaluated summary of hourly observations spanning 10 years at more than 400 U. S., Canadian and Mexican weather stations. Presents the 1%, 5% and 15% design levels of wet-bulb temperatures at each weather station, includes dry-bulb temperatures and wind speeds and directions coincident with high wet-bulb temperatures.

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Activated Carbon......Many heavy chemicals with rigid specifications can be purified economically with Darco . . . whether problem is color, odor, etc.
25 *Atlas Powder Co., Chem. Div.

Adhesive......8 p. brochure discusses company's new 910 adhesive, a cyanoacrylate said to form remarkably rapid and strong bonds between wide variety of materials.
108A Eastman Chemical Products

Alloy...... 2 p. technical data card, TDC-189, tells of high temperature properties of B&W Croloy 16-13-3, chemical composition, size ranges, tensile & rupture properties.
108B Babcock & Wilcox Co.

Ammonia......40 p. bulletin tells of purchasing, handling, storage, and uses. Photos, tables and figures illustrate sections on both aqua and anhydrous.
108C Pennsalt Chemicals Corp.

Caustic Soda......26 p. profusely illustrated handbook includes basic information on the various commercial forms of caustic soda. Details handling procedures.
108D Stauffer Chemical Co.

Chemicals......3 p. tabular brochure contains data on such products as phosphorus, phosphoric acid, sodium phosphates, organic phosphates and sodium chlorate.
108E Electric Reduction Sales

Chemicals......A new 27-page booklet on Physical Properties of synthetic organic chemicals is offered. Fifty-seven new chemicals appear in this edition for the first time.
108F Union Carbide Chemicals Co.

Chemicals, Aromatic......Newest issue of company's semi-annual price list, 36 p., is dated October 1958. Descriptions and market information cover aldehydes, gums oleoresins.
108G Dodge & Olcott, Inc.

* From advertisement, this issue

Filteraid ...... Neofil, carbon-based filteraid for difficult filtrations such as caustic or fluorated solutions. Available in 6 grades. An illustrated bulletin is offered..
111 *Great Lakes Carbon Corp.

Formaldehyde......29 x 19 in. wall chart includes minimum storage temperatures, flash points, first aid information, analytical methods, testing procedures.
108H Borden Chemical Co.

Formaldehyde......6 p. brochure gives complete specifications for 37% and 44% inhibited and uninhibited formaldehyde solutions, plus other general information.
108I Borden Chemical Co.

Formaldehyde......Two seminar papers prepared by company experts cover the salient physical & chemical properties, engineer, safety, control for handling.
108J Borden Chemical Co.

Furfural......In wide use as a selective solvent. Effective in separation of organic sulfur compounds, or heavy metal complexes from petroleum fractions. Bul. 203-A.
33 *The Quaker Oats Co., Chem. Dept.

Olefins......Complete information on specifications & characteristics of Tetrapropylene & Tripropylene & many other high quality petrochemicals is available.
75 *Enjay Company, Inc.

Packing Material, Plastic......32 p. bulletin describes Dowpac, company's new plastic packing material used in biological oxidation of liquid wastes.
108K Dow Chemical Co.

Propellents......Of particular value to aerosol fillers, 4 p. bulletin contains complete vapor pressure tables and other useful technical data on company's Isotron line.
108L Pennsalt Chemicals Corp.

Construction Materials

Alloys......How to fabricate "Hastelloy" alloys is the subject of a new 36-page booklet. Covers step-by-step procedures & recommendations for welding, forging, forming etc.
108M Haynes Stellite Co.

Bus Bars, Aluminum......feature excellent corrosion resistance. For use in process plants. Complete information contained in Bus Conductor Handbook, AD661.
108N Aluminum Co. of America

Castings, Stainless ...... A 28-page booklet of valuable & complete data on stainless castings. Included analyses, properties, technical data on handling & heat treatment.
41 *Allegheny Ludlum Steel Corp.

Coatings, Resin-based......guard paint production equipment from corrosion. Booklet, "Epon Resin Esters For Surface Coatings" is now available.
Cover *Shell Chemical Corp.

Stair Treads, Aluminum......are available in all standard sizes. They need no paint. Aluminum grating also available, for floors & walkways. Bulletin AD679.
108O Aluminum Co. of America

Steel and Aluminum Data......New edition of 256-page handbook includes analyses, characteristics, mechanical properties and tolerances for aluminum and steel.
108P Joseph T. Ryerson & Son

Tread Plates......available in standard aluminum and also bonded abrasive surface for extra non-skid protection. Complete information in Bulletin AD596.
108Q Aluminum Co. of America

Vacuum Retorts......used for high-temperature vacuum annealing. Facilities & skills cover a wide range of tanks, furnace retorts, tanks & other fabrications.
B121 *Rolock Inc.

Electrical & Mechanical

Air Motors......New bulletin covers over 100 popular Air Motors in the manufacturer's line. Power range from 0.3 to 24 hp. with speeds from 50 to 2,580 rpm.
108 R Ingersoll-Rand Co.

Control & Indicating Stations ...... New threaded-joint, neoprene-sealed stations afford safety for pilot lights, heavy-duty push-button stations, selector switches, etc.
18 *Crouse-Hinds

Floodlights......New catalog provides adequate descriptive and ordering information on manufacturer's line of floodlights. Includes "How to Select Floodlights."
108S Crouse-Hinds Co.

Fluid Power Equipment......Specifications, illustrations and descriptive matter on the complete line of Oilgear and Servocontrol Div. equipment given in Bul. 10051-G.
108T The Oilgear Co.

Gas Turbines......Bulletin 167 details operating experience with the Mark TA 750/1000 kw. gas turbine. Design features, fuels and application information.
108U Clark Bros. Co.

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109A Missouri Boiler and Tank

Comparators......for fast, accurate pH, Chlorine, phosphates or nitrates test. Handbook, "Modern pH & Chlorine Control", gives theory & application.
120 *W. A. Taylor & Co.

Conveying Systems......Air-line conveying provides fast, sanitary method of unloading, inplant transporting, mixing, & loading any dry materials. Bulletin No. M-588.
109B The Day Company

Drums......Alloy metal, stainless steel, & nickel & monel drums are featured. Offer protection against product discoloration, chemical changes & corrosive action. Details.
13 *Pressed Steel Tank Co.

Hand Trucks......Booklet tells how walkie-type trucks give one hand the power to move tons, and helps to determine which operator-led trucks are best for the job.
109C Automatic Transportation

Handling Devices......For the handling of radioactive, toxic or highly flammable materials. Manufacturer produces line of remotely controlled handling devices.
109D General Mills, Inc.

Scales, Bulk......are important to you in your receiving department . . . in profit control . . . in cost accounting dept . . . in batch proportioning & quality control.
102 *Richardson Scale Co.

Transports......for the chemical & process industries. Illustrated Bul. No. 257-T gives details on transports available for every liquid hauling purpose.
109E Doyle & Roth Sales Corp.

Vibrating Conveyors......Designs and dimensions for three new high-temperature vibrating conveyors are the topics of the manufacturer's Model HT catalog.
109F Carrier Conveyor Corp.

Heating & Cooling

Combustion Draft......Bulletin gives the what, where, how and why of draft as it affects the efficiency of combustion processes. Also details on draft gages.
109G Hays Corp.

Coolers, Packaged......specifically designed to produce chilled liquids in volume. Bul. No. 257-C illustrates four types for unusual cooling requirements.
109H Doyle & Roth Mfg. Co., Inc.

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109I Patterson-Kelley Co.

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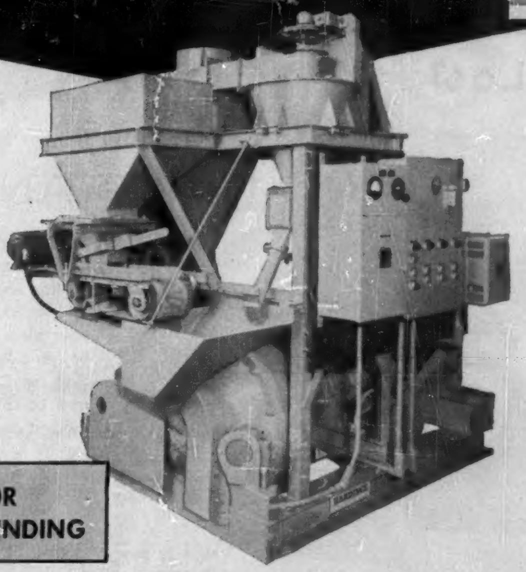

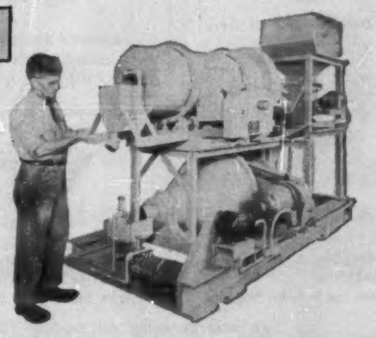

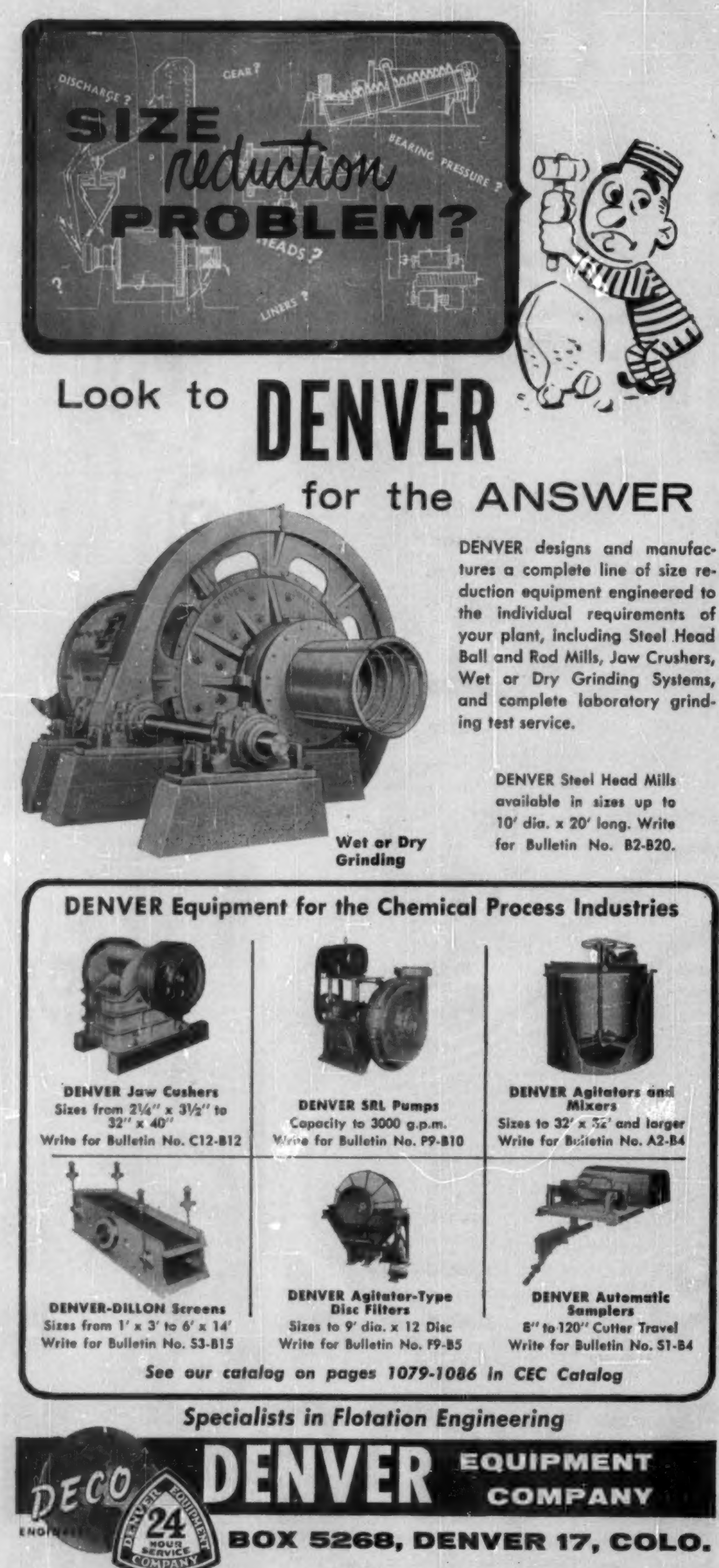

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Instruments & Controls

Dial Thermometers......A complete line is available with wide temperature ranges, dial sizes, patterns and finishes. A new catalog covers all details.
T112c *Marsh Instrument Co.

Industrial Control......Bulletin 958 illustrates manufacturer's line of industrial control devices. It also introduces a line of speed-responsive switches.
110A Euclid Electric & Mfg.

Manometers......Catalog 2008 gives full details and specifications on a redesigned and expanded line of well-type manometers for pressure, vacuum and differential service.
110B King Engineering Corp.

Needle Throttling Valves......gives micrometer regulation at high pressures. Pressure up to 10,000 psi and any temperature up to 500 F. Catalog available.
T112b *Marsh Instrument Co.

Pressure Gauges......combine features of pressure vacuum and compound gauges. There is a gauge for every conceivable application. New catalog for details.
T112a *Marsh Instrument Co.

Stream Analyzers......Bulletin CL-4000 includes information on the most complete line of process stream analyzers available from any one source, according to manufacturer.
110C Beckman/Scientific

Pipe, Fittings, Valves

Fittings ...... Complete dimensional data on a full line of stainless steel selding fittings and flanges is contained in revised catalog. Updated technical data.
110D Tube Turns

Pipe, Plastic......Precision molded pipe & fittings for every corrosion & flow problem include tees, couplings, flanges, reducing bushings, plugs, etc.
71 *U. S. Rubber Co.

Pipe, PVC......comes in sizes from ½ inch to 14 inches in diameter, & in schedules A, 40, 80 & 120. It does not contaminate sensitive solutions. Bulletin No. 24.
80 *U. S. Steel, National Tube Div.

PVC pipe and fittings......Brochure anticipates and answers the problems and questions most likely to arise when working with PVC pipe and fittings.
110E Mueller Brass Co.

Thermo Panels......take the place of pipe coils. Can be quickly installed or removed for cleaning. Complete data, including prices is available. Send for your copy.
TR121 *Dean Products, Inc.

Valves......New Gate & Globe are available from stock in ¼" thru 2" sizes & in both socket weld & screw ends. Feature hard faced seats & hardened discs & wedges.
50 *Henry Vogt Machine Co.

* From advertisement, this issue

Valves, Diaphragm......for handling viscous materials-semifluid foods, latex, magmas; solids in suspension-slurries, pulp stock, sludges; fluid-borne abrasives, etc.
14 *Grinnell Company, Inc.

Valves, Stainless......Bulletin 3 describes a line of jacketed stainless steel valves designed for fluids difficult to move at room temperatures. Send for your copy.
111A Alloy Steel Product Co.

Valves, Stainless Steel...... Aloyco valves offer staying power, minimum maintenance & corrosive service. Other types, alloys, sizes & pressures available.
1 *Alloy Steel Products Co.

Process Equipment

Agitator......The Flomix can handle over 400 GPM; viscosities of 75,000 SSU; pressures over 400 PSI; temperatures to 300 C. Complete details in Bul. No. 531.
101 *New England Tank & Tower Co.

Agitators......Turbine propeller type for effective agitation in tanks as large as 50' diameter. Details on agitators for repulping, mixing, scrubbing, etc. in Bul. A2-B6.
39 *Denver Equipment Co.

Agitators and Mixers......available in sizes 32" x 32" and larger. They are engineered to your individual requirements. Details contained in Bulletin No. AT-B4.
110e *Denver Equipment Co.

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110f *Denver Equipment Co.

Blenders.......Specialized information and complete data contained in Bulletin No. 16, Chemical Process Equipment & Bulletin No. 15A-1, Twin-Shell Laboratory Blenders.
20-21 *Patterson-Kelley Co.

Cabinet Cloth Filter Collector....... Model 81 requires only 28" x 28" floor space & provides cloth filtering area of 150 sq. ft. Complete details available.
111B Torit Mfg. Co.

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35 *Swenson Evaporator Co.

Dissolvers.......for ultimate dispersion, dissolving, emulsifying & deagglomerating in processing solid-liquid, liquid-liquid & gas-liquid materials. Information in catalog.
23 *Morehouse-Cowles

Dryers......Lectodryers stretch periods between defrosting...cut processing slowdowns & extend heat exchanger life. A detailed questionnaire is offered.
10 *Pittsburgh Lectrodryer Div.

Dryers, Rotating Vacuum......is available in six sizes and include provisions for steam or hot water heating. Complete information & application data available.
47 *F. J. Stokes Corp.

* From advertisement, this issue

Dust Collector.......The Ventrijet wet dust collector is particularly suited to collecting hot, moist, inflammable, corrosive & obnoxious dusts. Details in Bul. 922.
16 *Pangborn Corp.

Dust Collectors.......Illustrated folder gives details on models for gritty dust, for bulky or sticky dust & special models & equipment for every need.
112A Torit Mfg. Co.

Feeders, Airlock.....available in standard duty, heavy duty, & blow-thru types. Booklet P-58, "How to Select A Rotary Airlock Feeder", is offered.
B114 *Prater Pulverizer Co.

Filter......Tilting Pan, Horizontal Vacuum Filter provides multi-stage counter-current wash with complete separation of wash liquors from mother liquor.
4 *Bird Machine Company

Filter Papers.......free from linen & minerals. They are made under controlled conditions. Types for every need. Sample filter papers are available.
TL121 *The Eaton-Dikeman Co.

Filters, Disc.....The Agitator-type disc filters are available in sizes to 9" diameter x 12 disc. Bulletin No. F9-B5 gives full particulars on this type.
110e *Denver Equipment Co.

Filters......offer safe, effective filtering protection for your equipment. Available in a wide range of types & sizes. Descriptive literature offered.
113 *Wm. W. Nugent & Co., Inc.

Homogenizers......handle all kinds of emulsions and fit into any plant. Feature easy cleaning & maintenance, tight emulsions, no aeration & faster emulsification. Bul. 157.
112B Sonic Engineering Corp.

Jaw Crushers.......Bulletin No. C12-B12 gives complete details of this unit for the chemical process industries. Available in sizes from 2¼" x 3½" to 32" x 40".
110a *Denver Equipment Co.

Mills, Ball & Rod......for wet or dry grinding. Feature cast steel or Meehanite heads, large diameter trunnions, & single helical cast steel gear & pinion, etc.
12 *Kennedy Van Saun

Mills, Steel Head......Bulletin No. B2-B20 offers complete information on steel head mills available in sizes up to 10' diameter x 20' long, for your needs.
110g *Denver Equipment Co.

Mixer, Batch.......produces finished product in one operation. A new catalog describes the Troy line of angular mixers, colloid mills, roller mills & unit blenders.
B112 *Troy Engine & Machine Co.

Mixers......You'll find a wealth of information on fluid mixing in helpful bulletins describing Lightnin Mixers. These mixers adapt to changes in your process.
124 *Mixing Equipment Co.

Mixers.......Literature is available on the Simpson Mix-Muller which features a unique three-way kneading, smearing, spatualate action. You get mix that stays mixed.
48 *National Engineering Co.

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LITERATURE . . .

Mixers, Portable.......features high speed, slow speed & intermediate. Production & Laboratory models are available. Complete details in Special Bulletin 74B.
99 *International Engineering, Inc.

Precipitators.......A 22-page booklet gives full information on SF electric precipitators. Feature low installation & maintenance cost in dust collection systems.
103 *Buell Engineering Co., Inc.

Process Equipment.....Illustrated bulletin on change can mixers, roller mills, kneaders, rubber cement mixer, heavy-duty liquid mixers & High speed dissolver.
113A Charles Ross & Son Co., Inc.

Processor........Vacu-Film processor simplifies complex & difficult processing problems, particularly on time-at-temperature sensitive materials. Details in Bul. PE-98.
113B Rodney Hunt Machine Co.

Pulverizers, Packaged.......Two units are featured. One for small-scale continuous dry grinding and one for small-scale wet-grinding. Details on both units in Bul. AH-448-11.
109 *Hardinge Company, Inc.

Screens.....The Denver-Dillon screens in sizes 1" x 3" to 6" x 14" are outlined in Bulletin No. S3-B15. Especially designed for the chemical process industries.
110d *Denver Equipment Co.

Pumps, Blowers, Compressors

Air Filter......For compressed air systems has a dual cleansing principle and uses an interchangeable throw-away filter cartridge. For 10, 25 and 40 microns.
113C Perfecting Service Co.

Air Separators.......circulate production loads of up to 800 tph. Nine models available with diameters from 3 to 18 ft. Information contained in Bul. 087.
97 *Sturtevant Mill Co.

Compressors.......The Class FE compressor is one of several types available for process work. Suitable for direct motor drive or gear drive in sizes to 5,000 hp.
6-7 *Chicago Pneumatic

Compressor, Rotary......A new bulletin describes the new 365-cfm. rotary portable air compressor. Photos illustrate features of the unit, which runs at 1,100 rpm.
113D Le Roi

Pumps......The SRL pumps have a capacity to 3000 g.p.m. Bulletin No. PB-B10 features complete information on the design for your special requirements.
110b *Denver Equipment Co.

Pumps.......Corrosion-resistant pumps feature slot & pin device which keeps stainless steel sleeve & shaft rotating together. Also reusable rubber pump head.
73 *Waukesha Foundry Company

Pumps.......Single-stage, end suction pumps are available in capacities from 10 to 200 gpm. Feature vibration free shaft. Descriptive Bulletin No. 500 is offered.
98 *The Weinman Pump Mfg. Co.

* From advertisement, this issue

LITERATURE . . .

Pumps, Process.....The complete range offers all types of chemical process pumps, in all sizes & frames. Bul. EM-79, "Mechanical Consideration in Pump Design" is offered.
46 *Food Machinery & Chemical Corp.

Traps, Steam.....The 44-page, "Steam Trap Book" covers the excellent air handling characteristics & other features. Gives details on selection & installation.
11 *Armstrong Machine Works

Services, Processes, Misc.

Alignment Chart......Free 8½ x 11 in. alignment chart gives the log mean temperature difference if initial and final temperature differences are known.
114A Dean Products, Inc.

Analytical Methods......Paper decribes an improved method of determining acids and basic nitrogen compounds in petroleum products. It's simpler, faster.
114B L. Sonneborn Sons, Inc.

Cryogenics.....12 p. brochure describes engineering and construction facilities serving fields of ground support for missiles, cryogenic engineer & nuclear engineering.
114C Stearns-Roger Mfg. Co.

Disinfectants......Manufactured products for promotion of health & sanitation. Research with insecticides, soap, etc. Literature available with complete information.
114D West Chemical Co.

Exchanger Cleaning.......Detailed literature on this cleaning process and other chemical plant maintenance operations is available on request. Send for your copy.
100 *Oakite Products, Inc.

Filter Area Calculator......New slide-rule type filter area calculator determines required filter area on basis of both filtration rate and the cake capacity.
114E Niagara Filters

Kerr Cell Shutter.......Electro optical device designed especially for ultra high speed photography. Ideally suited for chemical reactions, explosion phenomena, etc. Bul. 4.
114F Avco Manufacturing Corp.

Rotating Drum Camera......for accurate recording of hypervelocity phenomena. Other applications are radiation studies, chemical recombination, etc. Bul. No. 9.
114G Avco Manufacturing Corp.

Rotating Mirror Camera......for accurate position versus time recording of hypersonic events. Bul. No. 8 outines application, camera construction & operation.
114H Avco Mfg. Corp.

Structures.....Facilities for the design, fabrication & erection of standard or special steel plate structures. Complete details in Field Services booklet.
69 *Chicago Bridge & Iron Co.

Tank Calculator.......Pocket-size slide rule determines capacity and size of storage tanks up to 100 ft. high and 300 ft. diameter. Capacities in gal., bbl. and lb.
114I Hammond Iron Works

* From advertisement, this issue

PROFESSIONAL SERVICES

The Consulting Engineer

"By reason of special training, wide experience and tested ability, coupled with professional integrity the consulting engineer brings to his client detached engineering and economic advice that rises above local limitations and encompasses the availability of all modern developments in the fields where he practices as an expert. His services, which do not replace but supplement and broaden those of regularly employed personnel, are justified on the ground that he saves his client more than he costs him."

CLASSIFIED . . .

EMPLOYMENT OPPORTUNITIES

CE's nation-wide coverage brings you tips and information on current opportunities in job functions throughout the chemical process industries.

▶ **Coverage** — National Executive, management, engineering, technical, sales, office, skilled. Positions vacant, positions wanted, civil service, selling opportunities, employment agencies and services, labor bureaus.

▶ **Displayed Rates**—$46 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 columns, 30 in. per page. Subject to the usual agency commission.

▶ **Undisplayed Rates**—$2.10 per line, 3 lines minimum. To figure advance payment count 5 average words as a line; box number counts as 1 line, 10% discount if full payment is made in advance for 4 consecutive insertions. Not subject to agency commission.

▶ **Closing Date**—January 26th issue closes January 3rd. Send new ads to Chemical Engineering, P. O. Box 12, New York 36, N. Y.

FIRST Class Equipment

FROM YOUR FIRST SOURCE

RUBBER and PLASTIC UNITS

* Battery of NEW UNUSED 14" x 30" Two Roll Farrell-Birmingham Mills with UNI-Drives
* Line of F-B. Mills 42" and 60" Rolls
* Stewart Bolling 2 Roll Mill 8"x16"
* Multi Platen Hydr. Presses 24" x 56" with (2) 10" Rams; 3000 PSI
* Erie Jacketed Extruder 6" x 66"
* Battery of Horizontal Sheeters Hydraulic 26" wide Knife
* Oswego Cutter 63" wide with 10 HP
* Ball & Jewell Rotary Cutter 10 HP
* 425 Ton Horizontal Hydraulic Sheeting Extruder complete . . .
* Baker Perkins Heavy Duty Dbl. Arm Jacketed Mixers; 300 Gal. 200 Gal. 100 Gal. and others; Several Cavagnaro Mixers in Stock too

MILLS AND GRINDERS

Mikro Pulverizers; all sizes from Bantam to No. 4

Mikro Atomizers; Stainless Lined; No. 5 and 6

International Porcelain Ind. Pebbles Mills 8'x8'

Abbe and Patterson Pebble Mills from 36"x42" to 6'x8'

Abbe Silex Lined Ball Mills: 5'x14' and 5'x16'

Patterson JACKETED Ball Mills; 54"x42"

1000 Gal. Jacketed Buhrstone Lined Pebble Mill; 6'x6'; 25 HP

Simpson Intensive Mix-Mullers 24", 36" and 72"

CENTRIFUGALS

A. T. & M. 26" Stainless Suspended Type

A. T. & M. Rubber Cov. 30" Susp. Centrifugal;

Tolhurst 36" S/S Suspended; with Plow and Bottom Dump

A. T. & M. 60" S/S Suspended center slung; Vapor tight

Sharples S/S Super-D-Canter; 10 HP

Sharples H2 Nozzlejector: 1000 GPH

Sharples C20 Super-D-Hydrator in 316 Stainless;

Bird Solid Bowl Continuous Centrifuge 32"x50"; 316 S/S

FILTERS

Dorreo Rot. Vacuum Filter; 6'x3' with nickel contacts

Feine S/S Rot. Vacuum Filter 5'x6' complete

Oliver Pre-Coat Rubber Lined Filter 8'x8'; 200 sq. ft. area

DRYERS

Hersey Rotary Gas Fired Dryer 5'x26' Counter Current complete

S/S Lined Rotary Dryer 50"x20' with Burner, Combustion Chamber, etc.

Stokes Rot. Jktd. Dryer 18"x8'

Bagley & Sewell Double Drum Dryer 28"x60"

Buflovak Dbl. Drum Dryer 40"x120" with accessories

Struthers Well Stainless Drum Dryer 4'x5'

REACTORS—EVAPORATORS

New S/S 125 Gal. Reactor; 30"x30" Jacketed; Agitated; motorized

Pfaudler Glass Lined Reactors 500 gal., 1,000 gal.

Blaw Knox Stainless Reactor 7'6"x7'6"; Jacketed,

1500 Gal. Steel Jacketed and Agitated Heavy Duty Reactor

Smith Stainless Lined 11,000 Gal. Pressure Tanks

Rotating Jacketed Aluminum Vacuum Fermenter;

Mojonnier S/S Vac. Pans 3'x10' and 6'x12'

Harris Stainless Vacuum Pan 6' Dia. wth coils

Zaremba Dbl. Effect INCONEL Evaporator 430 sq. ft. surface

Swenson Quadruple Effect Long Tube Evaporator;

Sargent & Wilbur Ammonia Disassociator; 10,000 cu. ft. per H

Swenson Lead Evaporators with Everdur Tubes; 300 sq. ft.

SEND for NEW ISSUE of "FIRST FACTS"

FIRST MACHINERY CORP.
209-289 TENTH ST.
BROOKLYN 15, N. Y.
Sterling 8-4672

CLASSIFIED . . .

EQUIPMENT SEARCHLIGHT

▶ Coverage — National Equipment and facilities—used, resale and rental—for the process industries. For sale, wanted, for rent.

▶ Rates—$21.75 per inch for all ads except on a contract basis; contract rates on request. An advertising inch is measured ⅞ in. vertically on a column; 3 volumns, 30 in. per page. Ads acceptable only in display style.

BUY ON TERMS!

SPECIALS FROM OUR STOCK OF OVER 10,000

Sperry 30" Filter Press, 54 plates and frames. Cast iron cl. del.

ACVO Delaval Centrifuge, 12 nozzle type 316 S.S.

Link-Belt 502-16 Roto-Louvre Dryer Completely equipped

S.S. Heat Exchanger, 96 1⅛" O.D. tubes, 144 sq ft area

Charlotte S.S. Model 20 Colloid Mill Horizontal type with 20 HP mtr

Sturtevant #2 Moto-Vibre Screen, type MU2306, 3'x6' double deck

For any item you need, wire or phone collect GA 1-1380

ME **MACHINERY AND EQUIPMENT COMPANY**
123 Townsend St. · San Francisco 7, California

SAVE ON GOOD USED MACHINERY

Centrifugals: 12", 30", 40" & 48".
Centrifuges: Sharples #5 & #6 Stainless
Dryers: Albright Nell 4x9 Atmos. Drum
Buffalo Vac. Drum Dryer 24"x20".
Vac. Shelf Dryers & Rotary Dryers.
Filters: Vallez type 49 Stainless covered leaves.
#2 Sweetland 12 Stainless covered leaves.
Filter Presses: 6" to 36" Iron & Wood.
Kettles: S.S. Jacketed, 80, 70, 60 & 50 gals.
Dopp 350 gal. cast iron Jack. Vacuum.
Devine Impreg. Units 30" & 36" dia.
Steel, Alum. & Copper 5 to 2,000 gals.
Mills: Raymond #00 Pulverizer 30 H.P. Alsc #0000
Mikro Pu'verizers #4, 2, 1, & Bantam
Hammer Mills & Pulverizers 3 to 50 HP
Ball & Jewell Rotary Cutters 1½ to 30 HP
Pebble, Jar & Ball Mills, Lab. to 8' x 8'.
Steel 3 Roll 9" x 32", 12" x 30" & 16" x 40".
Lehmann 4 Roll W.C. 12" x 36" Steel
Colloid Mills Stainless Steel 5 & 1½ HP.
Mixers: Baker Perkins Jack. 100 gals.
Day Imperial 75 & 150 gals. Jack.
Day Pony Mixers 8, 15 & 40 gals.
Day Jumbo 700 gal. horiz. mixer.
Blystone 3000# horiz. spiral mixer.
Dry Spiral Mixers 50 to 3000#.
Lancaster 6' dia. vert. mixer 25 HP
Pumps: Stokes etc. Vac. 10 to 500 CFM.
Gould 75 HP Centrifugal 250 PSI.
Sifters: Robinson 20" x 48" Gyro, 3 openings and others.
Tablet Machines: Single & Rotary Types ½" to 3".
Plastic Rubber Machy. Hydr. Presses.

Partial listings. Write for Bulletins.

STEIN EQUIPT. CO.
107—9th St., Brooklyn 15, N. Y.
Sterling 8-1944

MACHINECRAFT

S. S. Reactor 1200 gal. 200 lb. pressure.
Stokes 3-DDS2, 1-T, 1-RD3, 2-B
Baker Perkins 100 gal. S.S. double arm. 60 HP jacketed, vacuum, hyd tilt.
Blaw-Knox 2 gal. S.S. Autoclave 5000 lb.
50 gal. S.S. Autoclave 2000 lb. press.
Vulcanizer 60 in. x 9 ft. 125 lbs.
Oliver S.S. Pressure Filter.
Sweetland #2 all Stainless.
Stainless Steel Ball Mill.
Aluminum Condenser 350 sq. ft.
1—Aluminum evaporator, Calandria type, never used, 1300 sq. ft. tube area.
1—Baker Perkins 100 gal. double arm steel.
2—Procter & Schwartz finned drum driers.
Continuous stripping column 2 x 13 steel.

LOUIS SUSSMAN, INC.
800 Wilson Ave. (East of Doremus)
Newark 5, N. J. MI 2-7634

AUTOCLAVE WANTED

3000 to 6000 gallon. Type 316 or 347 stainless steel, solid or clad. Will consider glass-lined. To operate at 400 psi, and 400°F. Prefer heat coils but will consider jacketed type.

W-9506, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

WANTED

High Pressure Komarek-Greaves BRIQUETTE PRESS

with 20½" diameter x 9¼" wide rolls with or without feeder and pug mill.

W-9508, Chemical Engineering
520 N. Michigan Ave., Chicago 11, Ill.

NO. 430 HIGH CHROME S.S. PIPE

280' of 1¼"; 6880' of 2"; 7432' of 2½"; 374' of 3". 85,000 lbs. at 19¢ lb. Located at Meadville, Pa.

NEWMAN'S, INC
Box 1865, Tulsa, Okla. LUther 2-5228

Buying

Good Used Equipment

is frequently the difference between having needed equipment or doing without it.

We, at Brill, Take This Opportunity To Extend The Season's Greetings To All Our Friends In The Chemical and Process Industries

SPECIAL OFFER

12—Baker Perkins #15 JIM2 Double Arm, Steam Jacketed Mixers, 100 gal. operating capacity, hydraulic tilt, 20 HP motors.

STOCK ITEMS

1—Buflovak 550 sq. ft. Monel Single Effect Evaporator.
1—Blaw-Knox 1400 gal. steel, jacketed, agitated Vacuum Kettle.
1—10,000 gal. Horizontal Steel Pressure Tank, 200# psi.
1—4000 gal. 347 S.S. jacketed Reactor, 150# internal.
2—Pfaudler 1500 gal. glass lined, jacketed, agitated Reactors, 90# jacket.
4—Buflovak 750 gal. steel, jacketed, double motion paddle, agitated Kettles.
2—Sharples C20 & C27 Super-D-Hydrators, 316 S.S., vapor tight XP Timers.
1—Sharples H2 Nozzlejector, 15 HP, 304 S.S.
4—Bird 18" x 28", 24" x 38", 316 S.S. continuous Centrifuges.
1—Buflovak 48" x 40" nickel, single drum Flaker.
2—Buflovak 250 & 20 sq. ft., 304 S.S. forced circulation Evaporators.
2—Sparkler 33-S-28 Pressure Filters, 150 sq. ft., 304 S.S.
1—Niagara 36 H-110 horizontal 304 S.S. Filter, 110 sq. ft.

BRILL EQUIPMENT COMPANY
2401 THIRD AVE., NEW YORK 51, N. Y.
Tel. CYpress 2-5703 · Cable: Bristen, N. Y.
TEXAS OFFICE—4101 San Jacinto St., Houston 4, Texas—Tel. Jackson 6-1351

WORLD'S LARGEST STOCK—

DOUBLE ARM MIXERS

43—Baker-Perkins size #17 sigma-blade jacketed mixers, serrated blades and saddles, many with power-screw tilts, some with counter weights. Individually motorized units, and units with pulley drives. Located in Philadelphia and throughout the East.
1—Baker-Perkins #15-USE, 100 gal. Dispersion blade, T304 SS, vacuum cover, jacketed, 75 HP motor and drive.
2—Baker-Perkins #15, 100 gal., Sigma blades, jacketed, 20 HP.
1—Porter 75 gal., dual-worm, 50 HP.
3—W. & P., 50 gal., Sigma, jktd.
2—W. & P., 50 gal., non-jktd.
1—Baker-Perkins #14, vacuum, jktd., 50 HP.
2—Day 35 gal., Sigma, jktd. & non-jktd.
1—Day 5 gal., T304 SS, Sigma, jkt.

ROTARY KILNS

1—11' x 155' Traylor, 7/8" shell
1—9' x 130', 11/16" shell, 2-tire
1—8' x 170', 3-tire
1—8' x 126' Vulcan, 3/4" shell
1—8' x 115', 5/8" shell, 2-tire
2—8' x 50' Vulcan, 5/8" shell
1—7' x 120', 9/16" shell
2—6' x 60' Vulcan, 5/8" shell
1—4' x 24', brick-lined

SEND FOR INVENTORY LIST #159-A

PERRY EQUIPMENT CORPORATION
1413-21 N. SIXTH ST.,
PHILA. 22, PA.
POplar 3-3505

BUY ON TERMS!

2 ROLLER LAB RUBBER MILL

EEMCO 6"x12" Roller Mill, with cored rolls. 5 HP Reeves vari speed motor drive. 5.2 to 1 ratio. Excellent condition.

We Buy Surplus Rubber Equipment

Wire or phone collect—GA 1-1380

ME MACHINERY AND EQUIPMENT CO.
123 Townsend St. · San Francisco 7, Calif.

OVER 5,000 MACHINES IN STOCK

FOR EVERY INDUSTRY AND PURPOSE

- Wrappers
- Packaging machines
- Cartoning machines
- Fillers
- Labelers
- Filter presses
- Roller mills
- Mixers
- Pulverizers
- Grinders
- Dryers
- Sifters
- Cappers
- Tablet machines

TELL US YOUR REQUIREMENTS

Complete Details And Our Special Low Bargain Prices Available On Request

UNION STANDARD EQUIPMENT CO.
318-322 Lafayette St., New York 12, N. Y.
Phone: Canal 6-5333-4-5-6

DECEMBER SPECIALS

Devine Vac. Self Dryer 59x78 dbl. door.
Gen. American 42"x120" Twin Drum Dryer
Patterson 3/4 gal. S/S Jkt'd Lab. Mixer 2 H.P.
Day 40 gal. Pony Mixer with AC motor
Nash Hytor Vac. Pump #6, with 40 H.P. motor
Gruendler "BB" Hammermill, Whirlbeater

WE BUY
COMPLETE PLANTS OR SINGLE UNITS
WHAT HAVE YOU FOR SALE OR TRADE?
YOU CAN BANK ON

EQUIPMENT CLEARING HOUSE, Inc.
111 33rd Street Brooklyn 32, N. Y.
SO 8-4451—4452—8782

"SEARCHLIGHT" IS Opportunity Advertising

—to help you get what you want.
—to help you sell what you no longer need.

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GONDOLAS • BOX • FLAT
RECONDITIONED TANKS
ERMAN-HOWELL DIVISION
LURIA STEEL & TRADING CORP.
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What could be FAIRER?
For HIGH QUALITY and LOW COST
BUY
GELB
CHEMICAL PROCESSING EQUIPMENT

THE GELB GIRL—DECEMBER 1958

2—Heat Exchangers, type 18-8 SS, 1300 sq. ft. each
1—Tippett & Wood steel jacketed kettle, 2500 gal., ASME code
1—5000 gal. nickel clad horizontal storage tank

CENTRIFUGES:

1—32" suspended type centrifuge with imperforated basket
3—Tolhurst center slung centrifuges, 40" and 48" with rubber covered perforated baskets
1—Sharples #16P pressurite SS super centrifuge
2—Tolhurst suspended type centrifuge, 26" and 30" perforated baskets, complete

DRYERS:

4—Link Belt steel roto louver dryers, Model 207-10, 310-16, 310-20, 604-20
1—Buflovak double drum dryer, 42" x 120"
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
1—Stokes double drum dryer 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
1—Louisville SS rotary kiln, 30" x 28', complete
1—Stokes SS rotary vacuum dryer, 2' x 6'
6—Stokes steel jacketed rotary vacuum dryers, 3' x 15'

FILTERS:

1—Oliver horizontal filter, 6'6"
10—Sweetland filters #12 with 72 SS leaves
1—Sweetland #3 SS filter
1—Niagara SS filter Model 510-28
1—Oliver horizontal filter, 3'
1—Feinc SS rotary vacuum string filter, 3' x 3' (NEW)
10—Shriver plate and frame filter presses 12" to 42"
1—Shriver rubber lined filter press 36" x 36"

MIXERS:

5—Baker Perkins double arm sigma blade mixers, 100 gal.
3—Robinson type 316 SS sigma type jacketed heavy duty mixers, 300 gal. 60 HP
3—Howes 40 cu. ft. rubber covered ribbon blenders
1—Leader SS jacketed 51 cu. ft. ribbon blender

MISCELLANEOUS:

2—Heat Transfer Products steel bubble cap columns, 36" and 42" with 5 and 10 trays
1—Acme steel bubble cap column 42" dia. with 10 trays
1—Downington Iron Steel bubble cap column 24" dia. with 14 trays
2—Patterson Kelley, steel heat exchangers, 1000 sq. ft. each
6—Struthers Wells heat exchangers, 885 sq. ft.
1—Patterson Kelley steel heat exchanger, 427 sq. ft.
50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
30—Struthers Wells SS heat exchangers 650 sq. ft. each
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
2—Stokes tablet presses, Model T
1—Swenson type 316 SS vacuum crystallizer, 3'6" x 12'
1—Swenson type 316 SS vacuum crystallizer, 2'6" x 12'
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Badger type 316 SS bubble cap column, 42" with 11 trays
1—Stokes Model DDS2 rotary tablet press

2—Pfaudler glass lined jacketed reactors, 20 and 100 gal.

1—Hardinge Mill, 5' x 36"

2—Blaw-Knox steel distillation columns, 36" x '0' with 24 trays, complete (NEW)

Established 1886

R. GELB & SONS, Inc.,

CHEMICAL, RUBBER, OIL, PLASTIC and FOOD PROCESSING MACHINERY

U.S.HIGHWAY No.22, UNION, N.J. • MUrdock 6-4900

READER SERVICE . . .

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Brine gnaws holes in steel but can't eat through rubber

B.F.Goodrich improvements in rubber brought extra savings

Problem: Those tanks each hold 400 gallons of brine, used in processing canned onions. The solution is hot, and so corrosive it ate holes through welds in stainless steel tanks after only two months. It kept maintenance crews hopping—patching leaks, cleaning floors. Six months, and 75 patched holes later, both tanks had to be replaced.

What was done: At this point, a B.F. Goodrich man recommended lining the steel tanks with B.F.Goodrich "Saniprene". This is a hard rubber tank lining that's acid-resisting, does not contaminate food products. The rubber lining is locked to tank walls so tightly it practically becomes a part of the metal.

Savings: The two tanks, lined with 3/16" Saniprene rubber, have been in service over a year now, are still in excellent condition. There have been no leaks, no patching needed of the rubber or the metal. Engineers at the packing company expect the B.F.Goodrich lined tanks to last many, many times the 6-month life span of the unlined metal tanks.

Why specify B. F. Goodrich: If the waste and hazard of leaking acid tanks is a problem in your plant, call in B.F. Goodrich. You'll get the benefit of specialists who created the science of rubber lining and have had more experience in it than anyone else. You can be sure that the type of lining B.F. Goodrich recommends, produces and installs for you will put an end to messy leaks, costly repairs, expensive tank replacements. For more information, write *B.F.Goodrich Industrial Products Company, Dept. M-423, Akron 18, Ohio or to our plant in Tuscaloosa, Alabama.*

B.F.Goodrich ***rubber-lined tanks***

A message to every engineer who wants to keep fluid mixing costs down

Don't be fooled by *low purchase price* when you specify mechanical mixers for fluids.

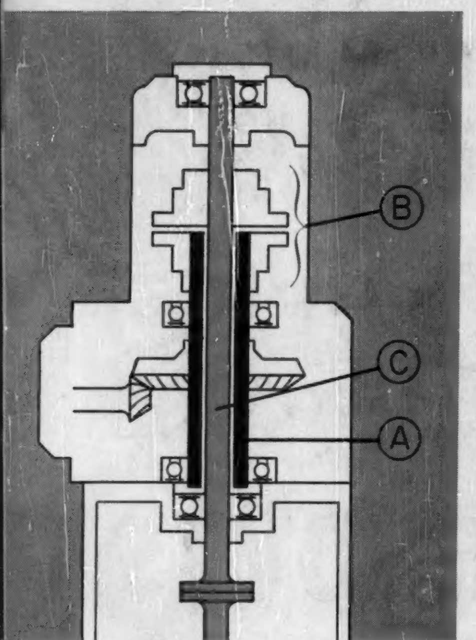
First cost is a very small fraction of your total mixing cost.

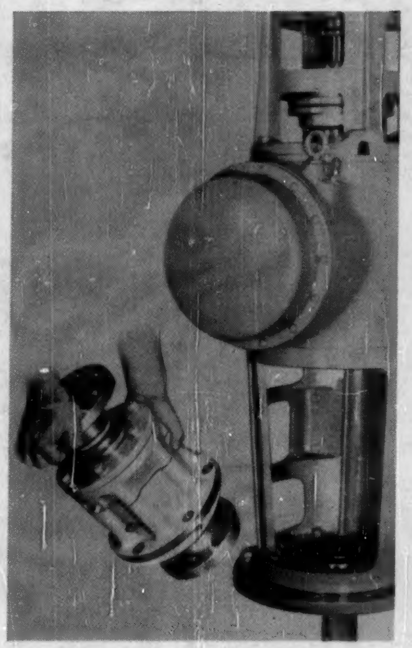
To find the *real* savings, look behind the price tag. Which mixer design will give you simplest, cheapest maintenance over the years? Most dependable month-in, month-out service? Greatest adaptability if mixing conditions change? Lowest spare-part requirements?

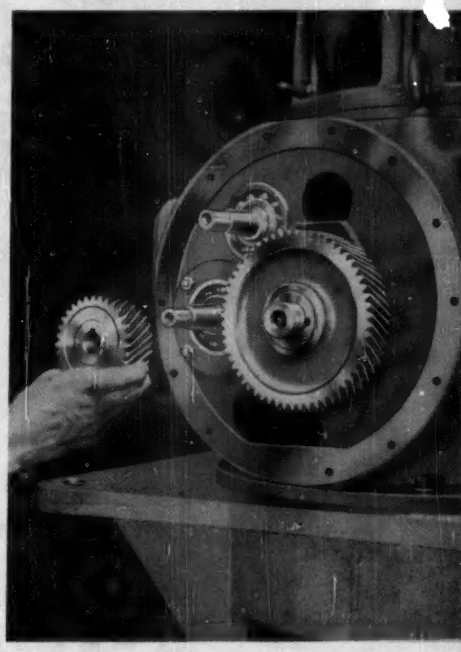
These are the areas where you can *really* save money on fluid mixing. And here are some of the reasons why you can do it more surely with LIGHTNIN Mixers than with any other mixer available.

For lower-cost fluid mixing, see your LIGHTNIN representative soon. He's listed in Chemical Engineering Catalog. Or write us direct.

Only *Lightnin* Mixers cut your mixing costs these 3 ways







1. PROTECTED GEARING. Ever think what could happen to a mixer's gearing if something in the tank should accidentally damage the shaft? Shocks or flexures *don't reach the gears* in a Series "E" LIGHTNIN Mixer. Hollow quill* (A) isolates gearing from shaft. Flexible coupling (B) transmits power from gears to shaft—soaks up mixer shaft loads. Mixer shaft (C) is easily removed without risk of disturbing gear alignment.

*Patented

2. EASIER, SAFER SEAL CHANGE. Cartridge-type rotary mechanical seal† eliminates leakage under pressure or vacuum, runs for years without adjustment, and can be replaced in minutes without skilled manpower *and without disturbing gearing or shaft alignment.* Basis of this extra safety and convenience is the hollow quill of the reducer, which lets mixer shaft move up and down freely. You get this construction only with LIGHTNIN Mixers.

†Patent pending

3. INTERCHANGEABLE SPEEDS. Should your mixing requirements ever change (within the mixer's rated limits), you can quickly adapt your LIGHTNIN to meet the new needs. Change gears‡ provide as many as 16 standard AGMA output speeds from the same basic drive. You can change speeds without dismantling the mixer or removing it from the tank. This cost-cutting feature, like all the others shown on this page, is a LIGHTNIN "first."

‡Patented

WHAT MIXING OPERATIONS ARE IMPORTANT TO YOU?

You'll find a wealth of information on fluid mixing in these helpful bulletins describing LIGHTNIN Mixers:

- ☐ Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP (B-102)
- ☐ Top entering; propeller types: ¼ to 3 HP (B-103)
- ☐ Portable: ⅛ to 3 HP (B-108)
- ☐ Confidential data sheet for figuring your mixer requirements (B-107)
- ☐ Laboratory and small-batch production types (B-112)
- ☐ Condensed catalog showing all types (B-109)
- ☐ Quick-change rotary mechanical seals for pressure and vacuum mixing (B-111)
- ☐ Side entering: 1 to 25 HP (B-104)

Check, clip and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 128-N Mt. Read Blvd., Rochester 3, N. Y.

In Canada: Greey Mixing Equipment, Ltd., 100 Miranda Ave., Toronto 19, Ont.

Lightnin® *Mixers*

MIXCO fluid mixing specialists